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The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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What is Cupola Melting Rate?

Everybody understands fairly well what is meant by "cupola melting rate," but nobody seems capable of postulating a definition generally acceptable to the industry. This is due to the following factors:—(1) Maximum rate is not normally established until a considerable time has elapsed after putting on the blast; (2) the diameter of the cupola is not a constant during a test melt; (3) as the end point of a melt is not too definite the elapsed-time factor cannot be related to this point; (4) as a rider to (3) any other time selected involves a survey of what is left in the cupola; (5) quite often it is difficult to weigh the liquid iron tapped from a cupola; (6) calculations based on metal charged involve the factors of dirt, metal losses and tret; (7) length of blow and (8) nature of charge.

A study of the above immediately brings into relief that two definitions are possible, the one of purely academic quality and the second of a commercial character. It is this latter which is of major importance, as a dispute between supplier and user may result in a definition being supplied to the industry by a High Court judge, which, apart from the cost involved, may not be universally accepted as it would be vitiated by the laws of contract as influenced by evidence and the agreement between the parties.

A sub-committee of the Institute of British Foundrymen is studying the question, and at the moment they incline towards one which would read that "the melting rate of a cupola is the amount of metal melted in terms of metal charged during the second hour of a 3- or 4-hr. melt." The flaw in the definition which has still to be overcome is that associated with keeping the cupola full and if normal practice postulates four charges per hour, the inclusion of five within the sixty-minute period is only too easily arranged. Thus it appears that there is no alternative to the actual weighing of either the liquid metal or the castings and scrap made. There are any number of tricks, such as the superheating of the cupola before putting on the blast, which can materially affect the result in the earlier stages.

All things considered, we think it best that the cupola manufacturers should send to the committee a schedule of inside diameters and what they consider to be standard melting rates of these for normal conditions, excluding any extra benefits they achieve from their own particular modifications. From such tables a curve could be constructed which we feel sure the foundry industry would accept as a reasonable basis for purchase and acceptation.

Recent Planning Schemes.—4 Industry's Response

One of the remarkable features of this country is the way in which, when changes are needed, independent thinkers are prepared to formulate proposals for improvement. In the main, the schemes we have described are put forward by people who have little or nothing to gain by them. They stand to lose, in so far as industry ultimately keeps, feeds and houses everybody. In many respects the schemes are identical. What does industry think of them?

The thing the industrialist prizes most is his entire freedom to start or stop a business as he thinks fit, and any restriction on this freedom is a handicap. And up to a point the system works marvellously well. In no country are people offered the variety of goods at the low order of prices at which they are available here. Hence the industrialist submits with ill grace to the steady encroachment of the State into industry, an encroachment that increases every year. He objects to planning unless he is responsible for it and carries it out. Any other planning interferes with his freedom of action, and hence restricts the services he can render. These services are very real.

Perhaps the only authoritative view for industry on this multitude of schemes is that of a Committee of the Federation of British Industries, and supported by the Council of the F.B.I. They say that the compulsion of minorities is a principle to be adopted only in the last resort, and that schemes put forward for industrial self-government are too far-reaching. They agree that a healthy industry must be financially sound and be free from overlapping and waste. But they do not agree that the extension of compulsion is called for. Brought about by legal and administrative restrictions, such compulsion would endanger freedom of thought and action. They agree that a much fuller organisation is required in industry, and that the individual must subordinate his views to those of the industry on the achievement of a common policy.

They agree that compulsory associations involve rigidity, which checks progress. They prefer voluntary associations, but would provide for Parliamentary action, where a small and dissenting minority may wreck a whole industry,

(*Concluded on page* 268.)

Metallurgical Training

DR. N. P. ALLEN, in the course of his presidential address to the Birmingham Metallurgical Society recently, gave an account of an experiment in metallurgical training which is at present being made by the University of Birmingham, and which was particularly interesting in that it moved away from the generally-accepted methods adopted by most universities and colleges. Metallurgy had in the past, said Dr. Allen, been considered as a branch of applied chemistry, and in the training of students the chemical aspects of the subject had tended to be predominant, particularly in the laboratory classes. This had followed from a pre-occupation with the smelting rather than with the application of metals. The most spectacular advances made in recent years, on the other hand, had resulted from improvements in the treatment and alloying of metals after the smelting stage had been passed, and it was significant that the vast majority of the research work carried out in the post-war period, which presumably affected the needs of industry during that time, had been on their physical rather than on their chemical properties.

In recent years an attempt had been made in the Metallurgical Department of the University of Birmingham, under the guidance of Prof. Hanson, to correct this bias and produce a balanced syllabus more suited to the needs of the present time by the introduction of a training in practical physical metallurgy which presented certain novel features. The course aimed at giving a practical understanding of the numerous changes which metals and alloys underwent in the processes of fabrication and adaptation to use, and occupied the whole of the laboratory time during the third and fourth years of the metallurgical course.

Beginning with the microscopic study of pure metals, the common alloys, and steels, followed by an introduction to pyrometry, the course proceeded to the manufacture on a small scale of brass and copper strip, of iron castings, the use and effects of hot or cold rolling, annealing and heat-treatment operations being included. Although quantities and sizes suited to the small scale of operations were used, every effort was made to keep the processes as close as possible to those in general use, and a point was made of subjecting the finished products to the ordinary mechanical tests, and meeting the standard specifications. In this, very considerable success was achieved, even with such comparatively difficult alloys as duralumin, though as a rule the products were defective in point of finish, the student not being able to acquire that skill in casting which was the result of years of experience.

In the second year of the course, attention was given to the use of the more recently-developed physical methods of investigation, such as the dilatometric and electrical-resistivity methods. The dilatometer had been found particularly useful in the study of complex alloy steels and electrical resistivity was useful for determining the limits of solid solubility. Time was also found for some work on some aspects of precipitation hardening and on the laws of grain growth.

The most recent development, still in an experimental stage, was the teaching of the use of X-rays in metallurgical work. The very rapid advances in this direction had made the attempt necessary, and it had proved to be practicable. Students had been able to make transmission photographs, to analyse a simple crystal structure, and to measure lattice parameters with approximate accuracy, whilst such details as grain size and preferred orientation could be examined. Although the student could not be made fully expert in this rather specialised branch in the time available, sufficient could be taught to give an idea of the scope and power of the method.

The difference between this and the more usual type of practical metallurgical teaching was considerable, and some might wonder whether the change was not too great. The final answer was to be found in the opinion formed by industry on the men who had received the course, about which it was perhaps too early to speak.

Metallurgical Research

The British Engine Boiler & Electrical Insurance Company, Limited, in which is merged the Manchester Steam Users' Association, has issued its Technical Report for 1933-34.

The work carried out in 1931 and 1932 on the relationship of a bend to a tensile test, states the Report, has been continued and extended during the past two years, during which period it developed into an investigation into the methods usually applied in making bend tests, involving much time and a large number of experiments. This extension has largely resulted from efforts at present being made by the British Standards Institution to standardise the bend test and devise a bend test suitable for weld metal. The results of the investigation show clearly that in many specifications certain requirements in the matter of bend tests are ill advised and that with the different methods of testing employed by the various test houses serious inconsistency may arise.

Apart from research work, a number of interesting cases of trouble which have come under the company's observation are described, and, while such trouble can always be classified under one or other of the headings (1) wear and tear, (2) bad design, material, or workmanship, or (3) negligence, many of them have a personality of their own: others owe their appearance in these Reports to the hope that by constant and repeated exposure of faults, whether in design or manipulation, improvement may eventually result.

Some idea of the nature of the Report can be gained from the contents, viz:—Failure of crankshafts and plain shafts; failure of the valve rod of an oil engine; crack in flywheel boss; faulty velocity wheel of a steam turbine; bearing metal troubles; failure of motor shaft due to the welding-on of fan blades; failure of motor shaft due to defective material; trouble due to the stepping of tube plates of water-tube boilers; serious failure of furnace plates; failure of a boiler plate due to chemical embrittlement; intergranular cracks in rivets; examination of overheated tubes in boiler plant; failure of a link of a crane chain; recent trouble in C.I. parts due to abnormality of the metal; method of determining distribution of stress in fusion-welded joints; note on heat-treatment of welds; porosity in weld metal; a method of determining the strength of weld metal within a welded joint; the bend test.

A Golden Jubilee

We extend our very hearty congratulations to the Norton Company, of Worcester, Mass, U.S.A., on the attainment of their fiftieth anniversary. We learn this through "Grits and Grinds," their house organ, which has included a four-page insert of gold metal paper, upon which has been set out, year by year, the important steps taken by the company, such as the starting up of their British, French and German plants; this is supplemented by a further tabulation of the company's major inventions, which concludes with last year's discovery of the commercial production of Boron carbide (Norbide). The house organ, which contains this, has been published for twenty-six years—itself a splendid record—especially when it is learnt that it runs to six separate editions in five languages.

Cast Iron as a Material of Construction

At the recent annual meeting of the Verein deutscher Eisengiessereien, PROF. DR. A. THUM, of Darmstadt, discussed in a Paper "Some New Applications of Cast Iron as a Structural Material," pointing out that the mechanical properties of cast iron had been much improved during the last decade. It now combines the advantages of ready formability with a comparatively low cost and suitability for mass-production processes, the mechanical properties being retained through every operation from the raw cast iron to the finished product. Surveying the present-day requirements of structural materials, Prof. Thum emphasised that, as regards mechanical properties, the *desiderata* have become much more stringent, since it was realised that these properties are quite definitely related to the formability and workability of the materials and the stresses they are called upon to sustain. Present practice is therefore to consider not only the statical properties, by which the tensile strength and elongation are taken as criteria of the quality of a material *per se*, but also the properties of the particular shape given to the material in processing. It is just in this direction that cast iron offers a considerable margin over other materials, while the great strength of modern cast iron, its excellent formability and low notched-bar value as compared with elongatable materials, open up for it many new fields of application. Thus, it has been successfully used for purposes which have been exclusively reserved to forged steel, such as for crankshafts. Moreover, in view of the great strength of thin-walled cast-iron structures, it has become competitive with aluminium alloys and welded steel, particularly in light structures. It is equivalent to these materials in view of its technological and mechanical properties, which very largely make up for the difference in weight as compared with the light metals. Yet it will remain a serious problem to the foundryman and designer to derive to the full all the advantages inherent in the use of cast iron. In continuation, Prof. Thum, by means of examples of fresh fields of application, showed how the confidence in cast iron of the designer has gradually grown and that its possibilities are steadily becoming realised by wider circles.

Catalogue Received

High-Duty Cast Iron. Ni-Resist austenitic cast iron is the subject of a four-page leaflet (F14) which has been issued by Messrs. S. Russell & Sons, Limited, of Leicester. This business has so developed that a new extension to the foundry has been made and this is illustrated on the back page. The plant is shown to include a Stein & Atkinson oil-fired furnace of 1 ton capacity furnished with a charging machine. The leaflet also carries illustrations of seven typical castings and the properties to be associated with Ni-Resist are detailed.

Recent Planning Schemes

(*Concluded from page* 267.)

through the Board of Trade. Thus compulsion would only be applied where voluntary action fails.

It is clear that industry itself is in favour of providing legislative means for carrying out desirable changes, and hence the schemes put forward need careful consideration by all employers. But industry is in favour of legislation to enforce compulsion only when every other resource open to the exercise of persuasive pressure has failed, and in general it is probable that most people in industry would endorse this as a representative industrial view.

The Institute of Vitreous Enamellers

SECOND ANNUAL CONFERENCE

In the course of the second annual meeting of the Institute, the members assembled on Saturday afternoon, September 28, in the Grill Room at Olympia, London.

The President (Dr. J. W. Mellor, F.R.S.), in a brief address, said vitreous enamelling would not be nearly so interesting as it is if there were in existence a complete therapeutics wherein every fault and every disease was tabulated, with an appropriate remedy. Those engaged in the industry would miss one of the most fascinating phases of the work, *i.e.*, the exciting hunt to find the primary causes of their varied troubles. He believed Lucretius had said, 2,000 years ago, "Happy the man who can find the causes of things." This might sound a little highfalutin'. But he gathered that the primary object of all manufacturers was to put as much "brass" as possible into the pockets of the proprietors and shareholders; other things were quite extraneous. The reduction of losses in manufacturing processes was one of the most important phases of the work from the industrial point of view. A man who had succeeded in reducing the manufacturing loss in the production of an article through the works from 15 per cent. to 5 per cent., had done very good work indeed; if he could get it down to 2½ per cent., so much the better. When a fault appeared in a works and the human element had been eliminated, one should not be satisfied with a temporary remedial measure; the sensible thing to do was to search for the primary cause and inquire as to what particular natural law had been violated in the course of the work. If that were not done we should always be in trouble as to why certain things happened—why, for instance, when the enamelling had gone wrong, one had to change from one supplier of raw material to another in order to eliminate the fault! It was ridiculous, but it was often done in other industries, and he supposed that it was done also in the enamelling industry. Several speakers on the occasion of the second Annual Dinner of the Institute, for example, had played shuttlecock with the idea that when the enamel went wrong the trouble was due to the cast iron. That proved that they did not know why the particular trouble was happening. So long as we were in ignorance of the laws regulating the course of events, we should have to take, with a "damn it," whatever Nature thought was an adequate punishment for our deviation from what she had prescribed for us. If, on the other hand, we adapted our processes to Nature's laws, she would help us; she would prove a good friend and, as the poet had said, she would "Give thee thy heart's desire." It was utterly futile to attempt to thwart her. She had a cold, cruel ferocity, she was merciless and implacable, and dire reprisals were sure to follow any attempt to oust her. This had been recognised by a Roman poet 2,000 years ago, when he had said "If you kick Nature out of the factory door she will come back through the window." It had also been said that "If she cannot get in by the garden gates she will climb over the garden wall." If we were to be masters and not the slaves of our processes and recipes we must adapt them to conform with Nature's laws. We should know what those laws were; if we did not know, so much the worse for us. Francis Bacon had put the matter into one felicitous sentence when he had said "Nature, to be conquered, must be obeyed."

Defects in Enamelled Ware

Mr. C. P. Stone then presented his Paper on "Common Defects in the Vitreous Enamelling of Cast Iron, Sheet Iron and C.R.C.A. Steel," which was printed in our last issue. The discussion was opened by the President, who said that the author had established his thesis, and had done so in an exceedingly clever and artistic manner. The Paper was one which would be elaborated from time to time during the next twenty years, or even longer. The author had drawn attention to the fact that enamel scrapings should not be allowed to dry; one imagined that Mr. F. H. Clews, who would present a Paper during the winter session on "Settling and Anti-Settling Properties of Clays," would have a good deal to say about that remark.

As one read the Paper, one became impressed by the relation between pottery and enamelled iron, and the Paper would help to clear up the puzzle as to what vitreous enamelling meant. In pottery one had to deal with a glaze and a body. The body might consist of a standard mixture of clay and flux, or it might be that barium compounds or magnesia compounds were the dominant factors. Vitreous-enamelled ware was like pottery, except that it had a metal body instead of a clay body. In future, when he was asked what enamelled ware was—as he had been asked about ten times within the last day or two—he would describe it as pottery with a metal body, having on that body an ordinary pottery glaze provided in a special manner.

The Rôle of Borax Treatment

Mr. J. T. Gray, after complimenting the author on his excellent survey, suggested there was a little contradiction in the section of the Paper headed "Sheet Metal." Mr. Gray said it was generally conceded that the hot-borax bath had two functions, namely, to assist in the prevention of rusting of the plates after pickling and the very fine coat of borax deposited on the plates acted as a flux for the enamel. A little later the author had stated that, after pickling, the plates should be scoured with dry sand. Surely, this scouring with dry sand would remove the borax and so defeat the object to an extent of at least 50 per cent., as there would be no borax left on the plates to act as a flux.

Mr. Stone said that probably Mr. Gray had in mind a rather strong solution of borax, whereas the statement in the Paper referred to a boiling solution of borax (3 lbs. per 100 galls. of water). If one used more there was a tendency to produce very serious tear marks in draining the enamel caused by borax drying on the face of the plate. For the production of really high-grade products Mr. Stone recommended that one should always apply dry-sand scouring. By so doing one removed any hydrate of iron and extraneous matter generally, and produced a satisfactory job. It was one of the old-time practices, though it had been omitted for quite a period, perhaps owing to its expense. In his view, however, it really paid for first-class work.

Mr. Gray asked what was the object of the borax bath in that case.

Mr. Stone said that the plates might have to be stored for 24 hrs. and the borax would prevent excessive rusting. But he emphasised that it must be used in the boiling condition, otherwise there would probably be trouble due to tarnish specks settling on the face of the plate, which often burn through during enamelling.

A member asked in what respect cold hydrochloric acid was considered preferable to hot sulphuric acid in pickling.

Mr. Stone said that in his experience the use of cold hydrochloric acid was not only more pleasant from the point of view of the workers, but there was certainly less tendency to over-pickling when hydrochloric acid was used. Mr. Stone much preferred it from every point of view.

High Iron Content Pickling Acid

Mr. Chiffey, commenting on the recommendation that the chemist should make analyses of the acid periodically in order to ascertain the iron content, asked what was the effect of using hydrochloric with a high iron content.

Mr. Stone replied that the use of acid of any description, if it were loaded with iron, resulted in slight crystallisation, which caused copper-head. An 8 per cent. iron content was usually recognised as the limit to which one could work satisfactorily, and even then there was a tendency to give a lot of trouble.

Replying to a further question by Mr. Chiffey as to what sort of crystallisation occurred, Mr. Stone said that the iron crystallised on the face of the plate, into the pores of the metal, and burned it into a copper-head, because the enamel cannot absorb the excess iron. By making frequent analyses to ascertain the iron content of the acid one eliminated a serious source of trouble. Sometimes acid was still in use even two or three weeks after it should have been scrapped.

Mr. Chiffey said he had asked the question for the very reason that some people objected to throwing away acid when it looked satisfactory, according to one test, whereas according to another test it might not be so.

Sheet Makers' Name Marks

Mr. B. B. Kent asked if the author could enlarge on his recommendation that the metal suppliers' trade or size marks should never be on the faces of the plates, as they were difficult to remove and often showed through the enamel. That recommendation was a little confusing, because certain suppliers, he had understood, applied the marks to indicate which was the better side of the plates.

Mr. Stone said it might be that certain people applied the marks to indicate the face of the plate, but he always instructed that the marks be applied to the back. He wondered how often Mr. Kent had seen enamelled pieces having the outline of the metal supplier's name or trade mark beautifully engraved in a series of fine boils on the face of the plate. Thousands of plates were returned each year for that reason. The plate manufacturers had devoted a lot of attention to the matter. They said that the marks were applied only by whiting; but it became rusted in, so that it was never removed. If the purpose of the marking were to indicate which was the face of the plate, that purpose could be served quite well if the manufacturers made it known that the marks were applied to the reverse side.

Acid-Proof Enamels

Mr. A. England, commenting on the question raised by Mr. Gray concerning sand scouring after treating the plate in the borax bath, emphasised Mr. Stone's reply that the borax was used to prevent rusting until such time as the enamel was applied to the plate. The time factor entered into the problem, and Mr. Stone would certainly advise sand scouring immediately prior to the application of the ground coat.

Mr. Stone agreed.

Mr. England pointed out that Mr. Stone had not referred to a "super" iron which was used a great deal in this country; it would be interesting to know Mr. Stone's experience of it as compared with ordinary sheet.

Whilst he agreed in general that there should be a wide firing range, Mr. England emphasised that if one impressed upon the workpeople the idea that an enamel had a firing range of from 750 to 800 deg., for instance, one might be asking for trouble. He had stated himself that there was a definite temperature at which any particular enamel would fire at its best.

He suggested that the Institute might tackle the definition of certain enamels. For instance, he did not agree with the term "acid-proof,"

and did not know of any true "acid-proof" enamels. It was to be noted that the term "acid-resisting" had also been used in the Paper. Mr. England knew of many enamels which were resistant to certain acids, but he added that, when anyone claimed that an enamel was acid-proof, he always suggested trying hydrofluoric acid. However, it was much better to use the term "acid-resisting" than "acid-proof."

Finally, he asked what temperature Mr. Stone considered to be best for the annealing of castings before enamelling.

MR. STONE, discussing the merits of iron *versus* steel, said he gathered he could refer to pure iron as "ingot iron," which latter term enabled him to cover a number of brands without transgressing the trade-mark laws; the term "C.R.C.A. steel" also covered a number of makes. For the last 15 or 16 years he had been enamelling steel in enormous quantities—up to 2,000,000 sq. ft. a year—and 90 per cent. of the metal treated during that period was C.R.C.A. steel. The metal to be used depended on the particular job. For example, if a sign had to be enamelled with twenty colours one would not dream of using C.R.C.A. steel; but one could probably use it for a sign having three or four colours, and be successful. Certainly he did not think that an expensive job, such as a refrigerator body, should be tackled in any material which was doubtful, but for the general run of stove plates such as he had in mind one could safely use C.R.C.A. steel in 90 per cent. of cases, provided one used a suitable enamel; he emphasised this, otherwise there would be failure. Those who wished to take the line of least resistance could use ingot iron; that would cost about £5 per ton extra; there were expensive jobs which might warrant its use. On the other hand, the hollow-ware trade would not think of using expensive ingot iron, and yet they were successful. One knew that it was specially treated for deep drawing, which probably rendered it much easier to work; but one could obtain flat steel plates in the pickled condition which would give highly satisfactory results and would enable a very big saving to be effected in the cost of the articles produced.

Whilst Mr. Stone agreed with the remarks made concerning the possible danger of allowing a wide firing range, he emphasised that one had to consider this matter from the point of view of the labour available. There was a shortage of really expert labour nowadays. Twenty years ago one could rely on a job being pulled out at the critical moment. To-day, however, the men were less expert, so that it was necessary to use an enamel which provided a latitude of probably a minute either way in regard to firing time and possibly a temperature range of 10 deg. either way.

Annealing of Castings

The annealing temperature to which he always worked was 800 deg., as the result of his experience of treating thousands of tons of castings a year. Many people urged that it should be 100 deg. higher than when enamelling. But the general enamelling range was from 720 to 760 deg., and if one treated the castings at 850 deg. the distortion factor became a danger, as also did the cracking and springing factors; one could not run that risk.

Discussing resistance to acids, he pointed out that in the third paragraph of the Paper he had referred to staining caused by ordinary vegetable acids in common use in domestic cooking, and had not mentioned hydrofluoric acid; but he would be pleased to exhibit enamels which were resistant for almost any period of time to acids other than hydrofluoric. Those enamels had been tested by companies of repute, and the only marks that could be established were caused by strong caustic. So that one was entitled to refer to them as "acid-proof" so far as the vegetable acids in common use in domestic cooking were concerned, rather than to confuse them with the "acid-resisting" enamels, because the latter were all stained by lemon juice; one authority in London had established that 10 per cent. of hydrochloric acid was equal to the strongest lemon, and Mr. Stone believed that that was about right. He always used it for a spot test on the enamels which he called "acid-proof."

The PRESIDENT, speaking with regard to acids, recalled that last February he had given a long *résumé* of work done on that subject in connection with pottery, and he had stated at the beginning that he did not know any alkali silicate, natural or artificial, that resisted the action of water.

Finally, the President recalled that in a book he had written not very long ago, which had been referred to as "Mellor's Nonsense," he had stated that if a good fairy promised to grant him any gift he cared to pray for, he would pray for the gift of seeing the obvious, of seeing what was staring him in the face.

Vote of Thanks

MR. J. W. GARDOM, proposing a vote of thanks to Mr. Stone for his Paper, said the subject had been dealt with on a common-sense basis, so that even those who had no knowledge of enamelling could understand a good deal of it. A very strong plea had been made for control, which was very important, but Mr. Gardom was rather in agreement with Mr. England that there was some danger in specifying a wide-firing range. If one were to have a wide range, why not say what that wide range was?

He thanked Mr. Stone very sincerely for not having suggested that iron castings were bad, even though he had said that enamels and everything else might be bad! But reference had been made to some of the faults which it was suggested should be eliminated, such as heavy lugs, etc., and variations of section. One wished that these things could be avoided; but, of course, the metallurgist and the foundryman must realise that progress was made only by doing the things which their grandfathers could not do, and they were producing castings with varying-sized lugs in a more sound condition than had obtained previously. He urged the Institute, as a whole, to consider the possibility of paying more attention to the internal structure of the cast iron. If a little attention and money were devoted to experimental work of that nature, he believed the founders would be able to produce iron castings of varying sections but with uniform structure. One of the arguments against it was that it cost a little more money; yet a lot of money was spent on enamelling and sand blasting and other processes, whilst at the same time the foundrymen's halfpennies were being knocked off.

MR. HALLSWORTH, seconding the vote of thanks, said he believed that a good deal of trouble was being experienced with regard to the white-enamelled crown plate on the gas cooker. He asked, therefore, whether it would be possible to design a gas cooker with an air space beneath the crown plate, for that would probably overcome a considerable amount of the trouble. He did not know whether or not that was done in the case of the electric cooker. Mr. Hallsworth also asked for Mr. Stone's opinion with regard to the use of hanging or double-decking for firing.

The vote of thanks was carried with acclamation.

Author's Reply

MR. STONE, responding, said he was anxious to remove a rather dangerous seed which Mr. Gardom had sown when he had referred to overcoming the trouble arising from castings with heavy lugs. One could spend a great deal of money in making a good-quality iron, but when the casting was 1 in. thick at one place and ¼ in. thick at another, one would either very much overfire the one or underfire the other. They might take a leaf out of the book of the Americans, who had proceeded in the direction of producing castings of even thickness, which made the most perfect job for enamelling. They removed all lugs and aimed at a very high standard of finish. It was true that they used lead, and so on, in huge quantities, and relied on a cooker being on the scrap heap within two years. But they did cut away heavy lugs, which were disastrous in certain castings, and particularly when they were handled by jobbing enamellers. Sometimes one saw a casting with a boss as big as one's fist at one end, whereas at the other it was about as thick as a piece of paper. That was not an enamelling job. The design was a matter of paramount importance, and, in his opinion, the quality of the iron occupied quite a second place. The moulder could render great help in collaboration with the designer, by producing even-thickness castings from clean moulds in which the gate was kept well away from the casting so that there were none of the boiling effects of pieces of coke and slag.

Commenting on Mr. Hallsworth's reference to difficulties experienced with crown plates, he pointed out that in electrical cookers there was not nearly so much trouble due to cracked crown plates as was the case in gas cookers, probably because in the electric cooker the grill pan was fitted into a slide, and there was a good air space between the grill pan and the plate. In the gas cooker, there was too close a contact between the grill pan and the enamelled plate, which did not allow free movement.

Replying to the question concerning double decking, he said he had always dealt with fairly high-temperature enamel. He had tried both systems in several plants, and for cooker work he had always found that he could definitely obtain a bigger production of good work in a week—not per load or per hour—by firing flat than by installing double decking. A fewer number of pieces had to be re-coated through pieces of scale falling off a bar at the top, always on the face of the casting. There was also economy in fuel consumption, and the cost of the running of the furnace was less. By using double decking, one could not put double as much work through a furnace as when using single decking; with double decking, one required to employ two men on loading, whereas with single decking he had never employed more than one man on the firing, on a production of nearly 100 tons a week.

A Large Pension Scheme

That the future of staff employees in industry should be made secure is a problem exercising the minds of large-scale producers. In his speech on October 2, Mr. W. Benton Jones, chairman of the United Steel Companies, Limited, which produces one-sixth of the steel made in this country and who have works as far apart as Yorkshire and Northamptonshire, Cumberland and Lincolnshire, showed how this important company is taking care of the future of its employees. A contributory life assurance and pensions scheme, for voluntary acceptance, has been inaugurated. It is far reaching, including not only the staff, from the junior typist to the highest-paid official, but foremen and establishment men. It provides both annual retiring pensions for men at sixty-five years of age and for women at sixty, and life assurance of a substantial amount at any time up to pensionable age. The scheme dates from July last, but long service prior to that date has not been overlooked. For each year of service from the age of 21 to the date of the commencement of the scheme, pensions are reckoned at half-rates. The eligible members of the staff of the United Steel Companies, Limited, have quickly grasped the opportunity afforded and already 99.5 per cent have enrolled.

Non-Ferrous Casting Alloys of High Strength*

By A. J. MURPHY, M.Sc.

The primary concern of the foundryman is the production of sound castings, and the means adopted to this end are governed ultimately by economic considerations. Foundrymen's technical associations and institutes therefore rightly devote much time to the discussion of those factors in melting, moulding, running, sand control, etc., which affect the quality and cost of castings. Constant attention to these points is necessary if castings are to retain their position in the face of competition from the different directions of forgings and fabricated construction, not to mention non-metallic moulded products.

The adaptability of the casting process which permits its application to the economical production of the most involved shapes will always remain a forceful argument in its favour, but there is, nevertheless, more than a tendency for the advocate of castings to be driven into a purely defensive attitude. It is well, therefore, for foundrymen to consider from time to time how wide is the range of work which they as a body can undertake. In particular it may be useful to consider what is the scope of the materials to which they can apply their art and science, and the present opportunity appears to be suitable for discussing the subject with reference to the mechanical properties of non-ferrous casting alloys.

Fig. 1.—Plain Brass, Zinc 33.7 per cent. Microstructure: All Alpha. × 50.

High strength is a purely relative term, and the significance of a numerical value of, say, tensile strength is not defined until information is available regarding the other properties of the material and the conditions under which it is required to operate. A simple but important example of this is seen in the relation between strength and specific gravity, which in aeronautical engineering makes a casting of an aluminium alloy with a tensile strength of 20 tons per sq. in. more useful than a wrought steel which has a tensile strength of 40 tons per sq. in., but which has a specific gravity three times greater than that of the aluminium alloy.

In other cases electrical conductivity, corrosion-resistance, machinability and even cost replace specific gravity as the attribute in relation to which strength has to be considered. The metallurgist who has to give attention to these factors in connection with foundry products required in the aeronautical, automobile, marine, railway, chemical, electrical and general engineering industries soon comes to appreciate the versatility of the non-ferrous casting alloys as a group. It is desirable to emphasise here that the present discussion is concerned only with casting alloys. By far the larger proportion of the data available on strong non-ferrous alloys, especially those published during recent years, refers to these materials in the wrought form; not only is it generally impossible to deduce from such information what mechanical properties are likely to be obtained from alloys of the same composition in the cast condition, but it is often found that alloys which have outstanding properties when worked appropriately are only of mediocre value as castings.

Table I.

Metal.	Zinc equivalent.
Aluminium ..	6.0
Tin..	2.0
Iron	0.9
Manganese ..	0.5
(Nickel)	(1.1 parts copper)

Table II.—*Mechanical Properties of Copper-Zinc Alloys Sand Cast.*

Zinc. Per cent.	Alpha phase. Per cent.	Maximum stress. Tons per sq. in.	Elongation. Per cent. on 2 in.	Brinell hardness.
33.7	100	15.0	63	55
35.0	88	19.1	59	59
38.0	75	21.5	56	64
40.1	69	23.0	55	72
41.8	55	24.6	50	80
43.7	14	27.8	27	102
45.5	0	30.4	27	105

Instances of striking mechanical strength are encountered among cast alloys having as their bases, respectively, copper, nickel, zinc, aluminium and magnesium. These alloys can be classified in two groups, according as the high strength is realised in the "as-cast" condition or is attained by subsequent heat-treatment.

The best known copper-base alloys coming within the subject of this Paper are the manganese bronzes and aluminium bronzes. If the term "bronze" is defined as indicating essentially an alloy of copper and tin it is not strictly applicable to either of these materials; the first should therefore be described as high-tensile brass and the second as copper-aluminium. In both cases, however, the term bronze is applied so commonly in commercial practice that there is little risk of it being misunderstood in this connection.

Table III.—*Mechanical Properties of Manganese Bronze, Sand Cast.*

Zinc. Per cent.	Alpha phase. Per cent.	Maximum stress. Tons per sq. in.	Elongation. Per cent. on 2 in.	Brinell hardness.
31.0	100	20.8	24	72
32.9	78	23.8	36	75
37.5	70	27.2	50	85
39.2	45	30.9	42	95
41.1	25	34.2	28	121
44.1	0	37.2	21	129
47.8	0 (δ present)	24.4	4	138

Manganese Bronze

The manganese bronzes used for castings are derived from the well-known brass containing 60 per cent. copper and 40 per cent. zinc, by alloying with these metals manganese, iron, aluminium, tin and nickel. All these five additional elements are rarely found together; iron in amounts from 1 to 2 per cent. is almost always present, the tin content does not change much from 1 per cent., manganese may vary from as little as 0.1 per cent. to 5 per cent., aluminium from 0.1 per cent. to 5 per cent., and nickel from 1 to 2 per cent. Among the normal casting alloys, which all contain iron as previously mentioned, those having a tin content of 1 per cent. generally have low aluminium and manganese contents, and those containing nickel have a very low percentage of aluminium. Two principal factors govern the mechanical properties of cast manganese bronzes: these are the microstructure and the chemical composition. The most useful bronzes are those having an alpha-beta or a beta structure.

Guillet's list of "zinc equivalence" factors shown in Table I is now well known. This ascribes certain numerical values to each of the addition metals to denote their quantitative effect, in terms of equivalent proportions of zinc, on the relative volumes of alpha and beta phases in a manganese bronze. In practice these factors are found to operate with good accuracy so long as the particular element considered is not present in amounts greater than about 2 per cent. It is well to remember that Guillet's rule is only an attempt to express in a simple manner the relations existing between the phases-fields in a ternary, quaternary or even more complex diagram of equilibrium constitution. The factor for assessing each metal in its zinc equivalence can only have a constant value so long as the boundaries between the alpha, alpha-beta and beta phase fields in the ternary diagram are straight lines and remain parallel.

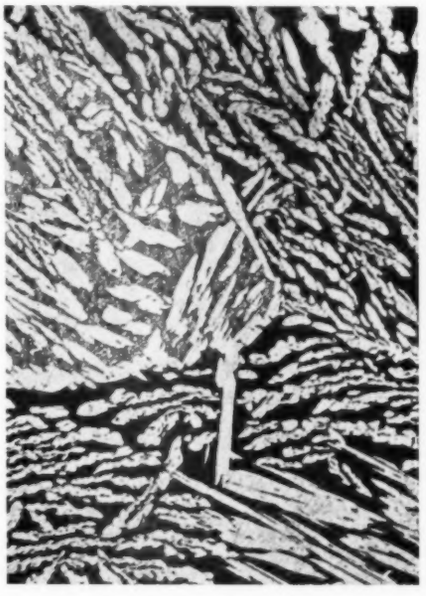

Fig. 2.—Plain Brass, Zinc 41.8 per cent. Microstructure: Alpha 55 per cent., Beta 45 per cent. × 50.

The transition from the all alpha structure to the all beta takes place in the sand-cast plain copper-zinc alloys over the range of zinc contents from 34 to 45 per cent. Table II shows

* Official Exchange Paper of the Institute of British Foundrymen to the 1935 Convention of the American Foundrymen's Association. Mr. Murphy is Chief Metallurgist to J. Stone & Company, Limited, of London.

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the progressive change in mechanical properties over this range of composition in sand-cast test-bars of the "straight" copper-zinc alloys, and Figs. 1 to 4 are photomicrographs at a magnification of 50 dia., illustrating the sequence of changes in the microstructure of sand-cast test-bars. It is of interest to compare these results with those observed in a manganese bronze containing, besides copper and zinc, iron 1 per cent., tin 1 per cent., aluminium 0.25 per cent., and manganese 0.25 per cent. The numerical data are given in Table III, and the corresponding photomicrographs in Figs. 5 to 8.

Just as in the plain copper-zinc alloys, the increase of zinc content in manganese bronze, which diminishes the proportion of the alpha constituent, causes a progressive increase in hardness and also in tensile strength until a wholly beta microstructure is attained. Other details in Table III, however, illustrate the greater complexity of manganese bronzes; as an example, it is seen that in the particular bronze considered, unlike the copper-zinc series, absence of the beta constituent does not correspond to the maximum ductility. This is due to the appearance in the copper-rich members of the series of the brittle eutectoid constituent of the copper-tin alloys. This is clearly seen in Fig. 5. It should also be noted that 1 per cent. of iron in the bronze is sufficient to cause the appearance in all the alloys of a third, so called "hardening," constituent.

The rapid change in properties accompanying a variation in the proportions of the alpha and beta constituents in manganese bronze obviously necessitates careful control of composition. The best practice in founding manganese bronze is to use previously-made ingot metal, and if this be done there is no appreciable change in the contents of the addition metals, iron, manganese, tin, etc., on remelting. Attention need only be concentrated on the zinc content, and in crucible-melting under reasonable control the loss of zinc is generally sufficiently uniform and consistent to permit a suitable allowance for this to be made in the original manufacture of the ingot. In air-furnace melting, such as is used for castings weighing some tons, the loss of zinc is less predictable, and must be corrected by the addition of spelter before casting. Fortunately, a rapid means of estimating the zinc content in most manganese bronzes is available in the examination of the fracture of sample chill bars. Using this method an experienced operator can judge when the correct composition is attained to an accuracy of ± 0.5 per cent. zinc.

The mechanical properties obtained in sand-

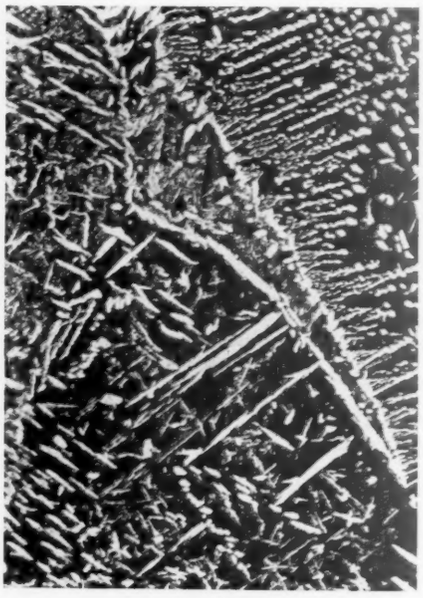

Fig. 3.—Plain Brass, Zinc 43.7 per cent. Microstructure: Alpha 14 per cent., Beta 86 per cent. × 50.

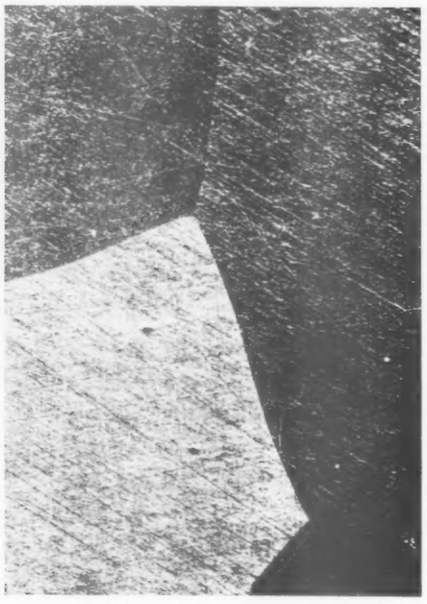

Fig. 4.—Plain Brass, Zinc 45.5 per cent. Microstructure: All Beta. × 50.

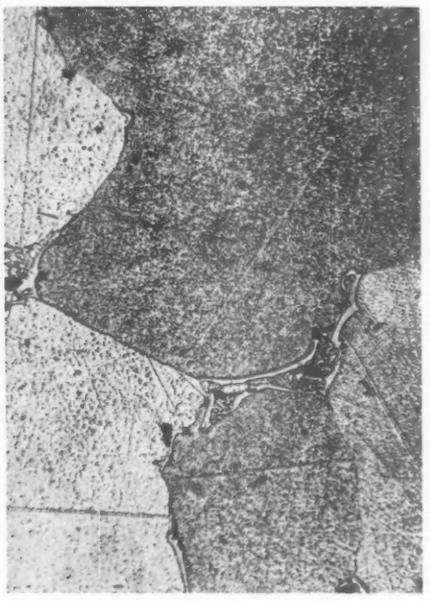

Fig. 5.—Manganese Bronze, Zinc 31 per cent. Microstructure: Alpha, with Copper-Tin Eutectoid at Grain Boundaries. × 150.

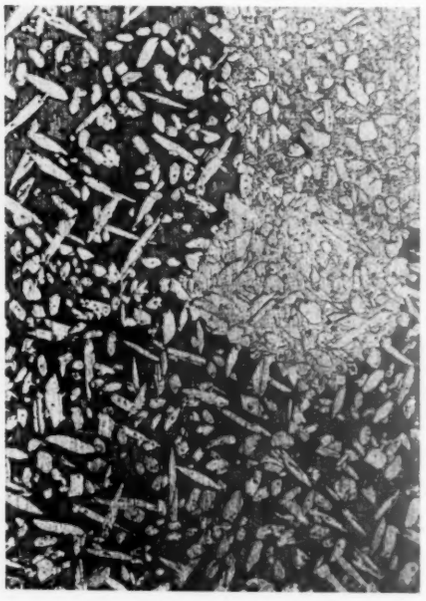

Fig. 6.—Manganese Bronze, Zinc 39.2 per cent. Microstructure: Alpha 45 per cent., remainder Beta, with Finely-Dispersed "Hardening" Constituent. × 50.

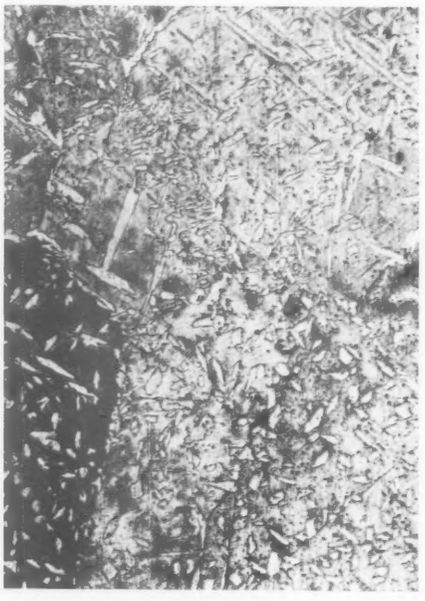

Fig. 7.—Manganese Bronze, Zinc 41.1 per cent. Microstructure: Alpha 25 per cent., remainder Beta, with Finely-Dispersed "Hardening" Constituent. × 50.

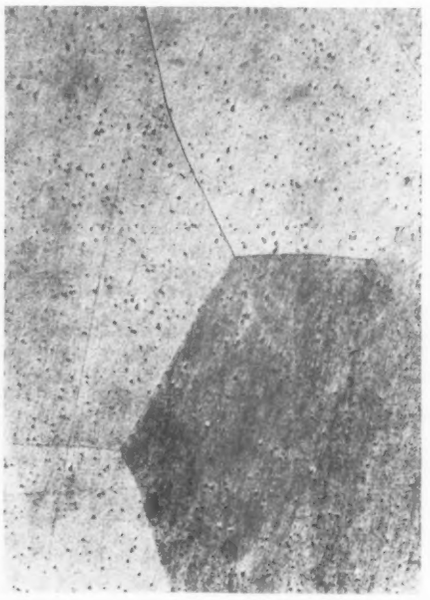

Fig. 8.—Manganese Bronze, Zinc 44.1 per cent. Microstructure: Beta, with Finely-Dispersed "Hardening" Constituent. × 50.

castings of manganese bronzes having an alpha-beta microstructure are:—Yield point, 15 to 20 tons per sq. in.; maximum stress, 30 to 40 tons per sq. in.; elongation on 2 in., 35 to 15 per cent.; and Brinell hardness (10/3,000/15), 100 to 180.

It is not proposed to discuss in detail the foundry technique, but it may be mentioned that the patternmaker's contraction is rather high ($\frac{1}{8}$ to $\frac{3}{16}$ in. per ft., according to the type of

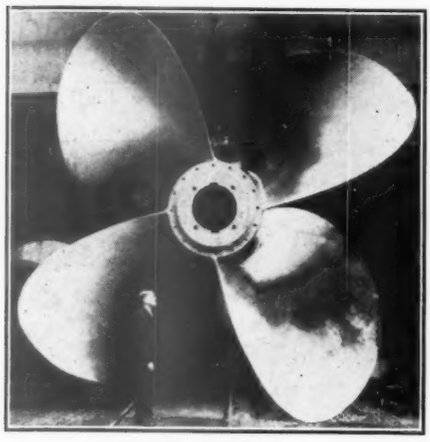

Fig. 9.—Manganese-Bronze Propeller, "Queen Mary." Finished Weight, 36½ tons.

casting), and the shrinkage on solidification is high. Special attention has to be devoted to providing for the high shrinkage by adequate risers, and care must be taken to ensure non-turbulent entry of the metal into the mould. In general principles the foundry technique for manganese bronzes resembles that for aluminium bronzes, but the difficulties are definitely not so great as in the latter case.

Applications of α-β Bronze

The applications of alpha-beta manganese bronze castings are very numerous. No doubt

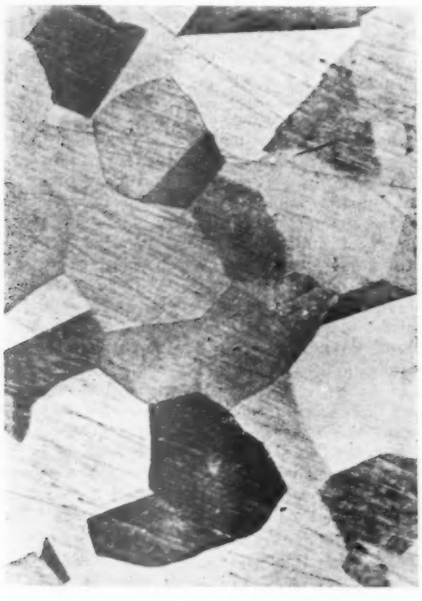

Fig. 11.—Aluminium Bronze, Aluminium 6 per cent. Microstructure: All Beta. × 100.

the best-known example is that of marine propellers, the casting weights of which may vary from about 40 lbs. for propellers of small yachts to over 50 tons for those of the Cunarder "Queen Mary." Fig. 9 shows one of these propellers, and Fig 10 one from the "Normandie," the finished weights in the two cases being 36½ and 26½ tons respectively. The example of marine propellers indicates the suitability of alpha-beta manganese bronzes for parts which are highly stressed and exposed to sea-water. At the same time, care has to be taken, in marine applications, to guard against abnormally corrosive conditions, such as are developed by galvanic action, due to the proximity of large masses of copper, as in copper-sheathed hulls. For land use, the manganese bronzes find application on account of their strength, resistance to corrosion and non-magnetic properties. Examples are provided by various ordnance parts such as gun mountings and races, rotor end caps and rings in turbo-electric generators.

Manganese bronze often proves its value in an emergency when a forged- or cast-steel part has to be replaced at short notice. The fact that a bronze casting having equivalent strength can be produced at very short notice is not so widely appreciated by engineers as it might be. No heat-treatment after casting is required to attain the mechanical properties previously quoted for manganese bronze.

Special mention should be made of the beta manganese bronzes. In normal sand castings of this type of alloy a tensile strength as high as 50 tons per sq. in., with an elongation of 15 to 20 per cent. can be obtained. Castings having properties such as these are obviously attractive for many purposes, and they are in fact giving satisfactory service in applications where non-magnetic properties and a capacity to withstand high centrifugal stresses are required. Caution is necessary, however, in using beta manganese bronzes for castings which may be exposed to corrosive conditions, and when the beta bronze contains aluminium it should not be adopted for parts subjected to stress while in contact with seawater, saline, ammoniacal or acid solutions. Under these conditions the aluminium-bearing beta manganese bronzes are liable to an insidious form of intercrystalline cracking.

Aluminium Bronze

The author has the impression that the second group of high-strength copper-base alloys, the aluminium bronzes, has received more attention in recent years in America than in Great Britain, at least as regards their application as sand castings. The sole reason for this apparent neglect is the rather formidable difficulty in foundry technique which they present and which effectively discourages the foundryman who, accustomed to the methods suitable for moulding and casting in brass and gunmetal, attempts to deal with aluminium bronze in the same way. It is unnecessary on this occasion to enlarge on the methods which have to be adopted for the successful production of aluminium bronze castings, it will suffice to say that the fundamental causes of the casting difficulties are, first, the great change in volume when the liquid bronze solidifies and the narrow range of temperature over which solidification occurs, and secondly, the high reactivity of the aluminium in the molten bronze towards oxygen and steam, and the tenacious character of the oxide films produced.

The first feature demands special attention in the provision of adequate risers and chilling, while the second calls for special care in avoiding turbulence in the entry of the metal into the mould. It is in the latter direction that the foundryman's ingenuity is most severely taxed. It is sometimes said that the aluminium founder takes more kindly than the brass-founder to casting aluminium bronze, and while it is true that many of the methods required are more akin to those adopted in handling the light alloys of aluminium, the higher casting temperatures of aluminium bronze aggravate considerably the troubles which arise from oxide formation.

The large volume of vapour generated at these temperatures in a sand mould, even when it has previously been stove-dried, not only causes marked turbulence in the incoming metal, but also multiplies the opportunities for oxide formation. The absence of this factor in die-casting goes far to explain the greater ease with which clean castings of aluminium bronze can be made in permanent moulds as compared with sand moulds; it also emphasises the necessity for

Fig. 10.—Manganese-Bronze Propeller, "Normandie." Finished Weight, 26½ tons.

free venting and the use of sand of high permeability.

Normal values of tensile strength in aluminium-bronze sand castings are from 30 to 45 tons per sq. in. In the plain copper-aluminium alloys the compositions used for sand casting are generally restricted to the range 8 to 10 per cent. aluminium, the corresponding range of mechanical properties in the sand-cast condition being:—Maximum stress, 25 to 32 tons per sq.

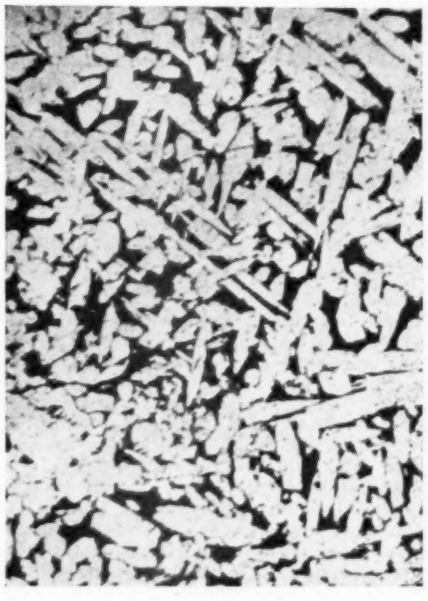

Fig. 12.—Aluminium Bronze, Aluminium 8.4 per cent. Microstructure: Alpha 50 per cent., Remainder Beta, with Ternary Constituent. × 150.

in.; elongation on 2 in., 60 to 25 per cent.; and Brinell hardness, 70 to 100.

As sand-cast in a section of about 1 in. thickness, the alloy with 8 per cent. aluminium has a wholly alpha microstructure, and with 10 per cent. aluminium consists of practically equal

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proportions of the alpha and beta phases. The limits of mechanical properties mentioned correspond to these two compositions. In passing, it is interesting to compare these data with the corresponding values in the plain copper-zinc alloys. When the microstructure is just completely within the alpha range, the approximate figures for sand-cast 1-in. dia. bars are:—

	Maximum stress. Tons per sq. in.	Elongation. Per cent. on 2 in.	Brinell hardness.
Copper-aluminium..	25.0	60	65
Copper-zinc ..	15.0	65	50

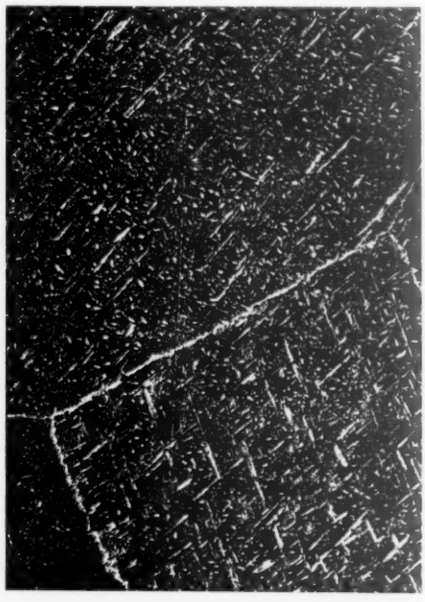

Fig. 13.—Aluminium Bronze, Aluminium 12.2 per cent. Microstructure: Beta, with trace of Alpha and Ternary Constituent. × 200.

In the alloys containing approximately equal proportions of the alpha and beta phases the corresponding values are:—

	Maximum stress. Tons per sq. in.	Elongation. Per cent. on 2 in.	Brinell hardness.
Copper-aluminium..	32.0	22.0	95
Copper-zinc ..	25.0	50.0	80

It is evident that in alloys of similar constitution the aluminium bronzes are intrinsically stronger than the copper-zinc alloys. The plain copper-aluminium alloys, however, are prone to a disability from which the brasses are free, namely, "self-annealing." This is a type of embrittlement which is liable to occur when the alloy cools slowly through the range of temperature in which the transformation of the beta phase to alpha delta occurs. In equilibrium the temperature of this change is at 540 deg. C., and in sand castings of heavy section it is difficult to ensure rapid cooling at this temperature. Various devices can be adopted to avoid "self-annealing," such as the use of local chills, knocking out castings from the mould at a high temperature, or the castings can be reheated above the transformation temperature, quenched and tempered.

A much simpler remedy, however, is to use a ternary or quaternary alloy, containing iron, or iron and nickel, and the plain copper-aluminium alloys are now largely replaced by those containing up to 5 per cent. each of these additional metals. The effect of these additions on the constitution of the copper-aluminium alloys has not been thoroughly investigated, and it is not certain whether iron, for example, eliminates the eutectoid transformation of the beta phase under equilibrium conditions, or merely so reduces the rate of transformation that no appreciable amount of embrittling delta constituent is formed even with slow rates of cooling. In any event, the practical effect of the iron is to suppress "self-annealing" even in heavy castings produced under normal conditions.

A typical example of the ternary aluminium bronzes has an iron content of 3 per cent., and Table IV gives an idea of the effect of

Table IV.—*Influence of Aluminium in the Mechanical Properties of Aluminium-Bronze.*

Al. Per cent.	Alpha. Per cent.	Maximum stress. Tons per sq. in.	Elongation. Per cent. on 2 in.	Brinell hardness.
6.02	100	32.2	52	103
8.42	50	35.6	48	111
10.12	10	40.4	28	137
12.20	Trace	37.4	3	217
13.60	(δ present)	18.8	<1	277
16.0	(δ present)	—	—	363

variations in aluminium content on the microstructure and mechanical properties of the sand cast alloys, while Figs. 11 to 14 show characteristic microstructures in this range.

The most useful alloys in this series are those containing from 8 to 10 per cent. aluminium, and the relation to the plain copper-aluminium alloys is analogous to that between the manganese bronzes and the simple brasses. It is noticeable, however, that in the aluminium bronzes the increased strength for a given proportion of alpha and beta phases resulting from

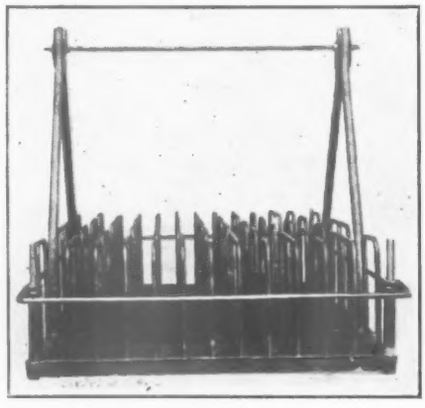

Fig. 15.—Aluminium Bronze, "Superston L. 189." Pickling Crate.

the addition of 3 per cent. iron is accompanied by an increase in ductility.

By the addition of nickel as well as iron, still further improvements in strength are obtainable. As an example of this class of aluminium bronze may be mentioned Superston L. 189 Bronze, which contains approximately

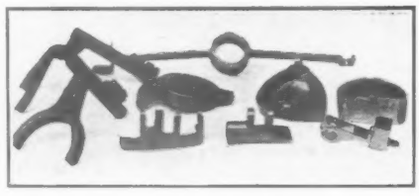

Fig. 16.—Aluminium-Bronze Die Castings.

5 per cent. each of iron and nickel, and has the following properties when sand-cast:—Maximum stress, 42 to 45 tons per sq. in.; yield point, 22 tons per sq. in; elongation on 2 in., 15 per cent., and Brinell hardness, 160 to 190.

The outstanding differences between aluminium bronzes and manganese bronzes, apart from founding properties, are seen in the fatigue strength and the behaviour in corrosive environments. In general it is found that the safe range of stress under fatigue is considerably greater in aluminium bronze than in a manganese bronze of equal tensile strength. Superston L. 189 Bronze, with a tensile strength of 42 to 45 tons per sq. in. has a fatigue strength of ± 15 tons per sq. in. on a basis of 20,000,000 reversals, whereas in Superston Fifty, a manganese bronze having a tensile strength of 50 tons per sq. in., the fatigue strength on the same basis is ± 9.5 tons per sq. in.

The excellent resistance to corrosion by seawater, mineral acids in moderate dilution, acid

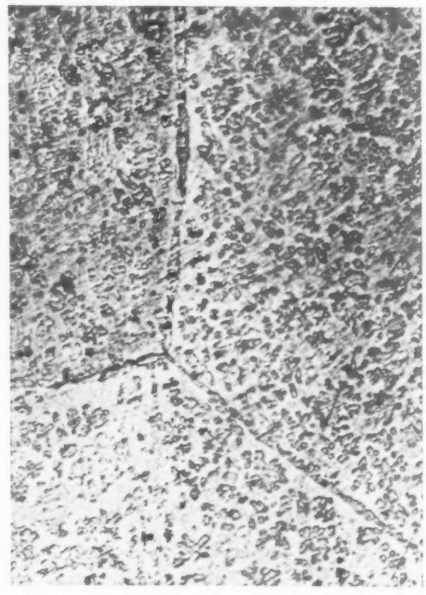

Fig. 14.—Aluminium Bronze, Aluminium 13.6 per cent. Microstructure: Beta, Delta and Ternary Constituent. × 200.

vapours and numerous chemical reagents accounts for many of the applications of aluminium bronzes. An interesting feature of these bronzes is their ability to resist electrolytic, or galvanic corrosion when in contact with copper in saline solutions. In this property, which is no doubt due to the formation of a protective film having aluminium oxide or hydroxide as a basis, aluminium bronzes show a marked superiority over manganese bronzes.

The combination of high strength with very useful corrosion-resisting properties, allows aluminium-bronze castings to be used for such parts as cradles, crates, racks and hooks in steel-pickling plant, components of valves handling brines and acidic liquors, fan blades exposed to acid vapours, and stressed parts such as gearwheels liable to be immersed in seawater. Fig. 15 shows a pickling crate made of aluminium bronze, the base being a casting of Superston L. 189 bronze. Even where corrosion is not involved, the hardness and strength of aluminium bronze castings justify their application, as for example, in worm-wheels, die-cast levers, and striking forks of automobile gear-boxes, and certain types of engine cylinder heads. Typical die-castings in aluminium bronze are shown in Fig. 16.

In order to preserve a true balance in the inevitable comparison of aluminium bronzes with manganese bronzes it is necessary to emphasise the advantage which the latter possess in ease of casting. This consideration is often sufficient to turn the scale in favour of the manganese bronze in cases of complicated castings, even when aluminium bronze would be preferred on its general properties.

(*To be concluded.*)

Castings

By W. MACHIN and M. C. OLDHAM

(*Continued from page* 212.)

Defective Castings

Defects in castings are caused through many faults, which can be attributed to design, patternmaking, supervision, moulding coremaking, metallurgy and other and more minor operations connected with manufacture, also inferior or unsuitable materials as mentioned. It is a very extensive subject, but it may be an advantage to go briefly into the matter, so that the overseer who examines the casting and may not have had foundry experience, will be able to lighten the load of those connected with manufacture when he examines any defect shown to him during his daily tours round the defects department.

The defect which is these days usually considered the most serious is that which the overseer calls a crack, but which is better known in the foundry as a hot tear, and is seen more on a steel casting than on iron or non-ferrous. The cause of these hot tears has already been touched upon briefly, and those castings upon which they can be seen with the naked eye are generally rejected before they leave the foundry. In other cases they are found during machining, or when the casting is subjected to water pressure, or X-Ray examination.

The causes of these hot tears can be definitely identified with the contraction of the casting being retarded, having been held by some part of the mould or core during the cooling period. It will be noticed that a contraction tear is shown running transversely, between the flange and one of the seatings. This tear is not due to the core binding the contraction through the diameter of the pipe, but is definitely caused by the casting being held by the seating and the flange, which has retarded the contraction of the casting lengthways.

If the tear had been traversing the length between the flanges, the foundryman would have immediately attributed the cause to the core having been made too rigid. It is therefore necessary in this case, to see that the replace casting is manufactured with a lighter mould, so that no part of the casting be held when it commences to contract.

The place where this casting cracked was under a feeder. The extra heat from this feeder weakened the casting to some extent at the defective part, and when contraction commenced, the casting naturally cracked at that part.

A material at this temperature is obviously extremely weak, and no resistance must be offered by the sand to free contraction, or the stresses set up will prove too much for the material to resist. Fig. 101 shows a close-up of this hot tear. To eliminate such a defect a weaker mould is necessary, and the method adopted of constructing the mould with cavities in front of those parts held by the sand, would give the desired result if carefully carried out.

The cavities referred to are shown inside each of the flanges in Fig. 102. They are formed by cutting away the sand during the ramming of the mould, and filling them with cinder material, or fine sand. It is also necessary to carry the holes through the top half of the mould to meet the cavities.

This method enables the moulder to insert a bar in the holes in the top part, and knock it through the entire mould, which allows the cinder or fine sand to run away through the bottom of the mould. The flanges are then free to move, and the contraction is not hindered by projections being anchored in solid sand. The contraction on this width in cast steel is approximately four and a-half inches, *i.e.*, when cold the casting is four and a-half inches smaller than the pattern.

The hooks shown on the ends of the arms of the casting, shown in Fig. 103, were dealt with during moulding on the same lines as that shown in Fig. 102. It is essential that cavities be made inside these hooks so that the mould be easily removed during the easing stages shortly after casting. If this were not done the arms would be anchored, and serious contraction defects, *i.e.*, hot tears, would occur close to the heavy section nearest to the hook shape on the end of the arms.

Green Sand Moulds

Various methods are used to weaken moulds at the parts similar to those illustrated, the best known is to cast in moulds that are not dried, *i.e.*, what is termed in the trade "green sand moulds." The latter method is not reliable, however, except on very small work, on account of undried moulds being too weak to resist the wash of metal. The foundryman therefore has of necessity to resort to such methods as described when the moulds are dried.

The bars which carry the weight of sand in Fig. 104, inside the moulding box frame are all loose, and are tapered, so as to allow quick and easy removal after casting has taken place. Some of the holes seen are for feeding purposes, and the remainder are connected to grooves in the mould for quick removal of sand, which is in front of projections of metal on the casting, and therefore require to move inwards during contraction as shown in Fig. 102.

The two bottom halves of moulds shown in Figs. 105 and 106 indicate how the moulding boxes are screwed together in pieces, to allow them to be easily dismantled after the moulds are poured. These two moulds are seen with cores assembled, and are for the top and bottom halves of a high-pressure cast-steel turbine for marine service.

The top runners on each side and at each end of the moulds are so placed to obtain even temperature throughout the length, and also to obtain hot metal in the feeders, which can be seen in Fig. 104. These illustrations are shown to indicate the methods used when the mould is being constructed, so as to eliminate hot tears.

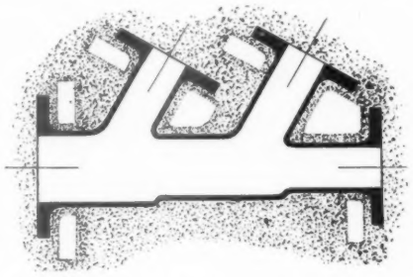

Fig. 102.—Section of Mould For Pressure Casting.

Fig. 103.—Part Section of a Casting 24 ft. Wide.

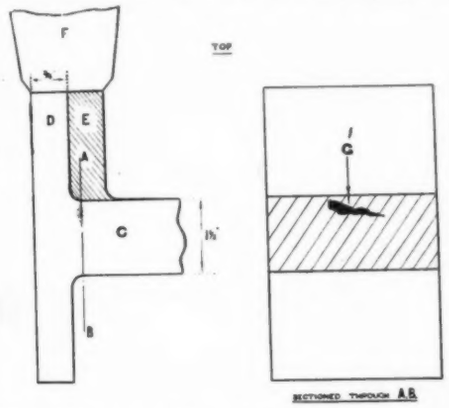

Fig. 107.—"T" Section showing Shrinkage Defect.

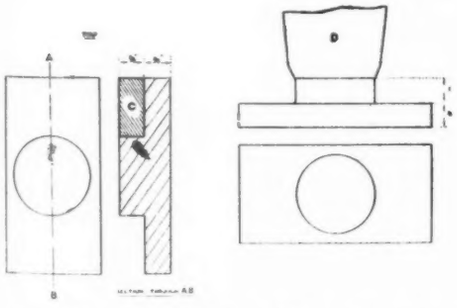

Fig. 108.—Two Pieces of Metal Cut from a Steel Casting.

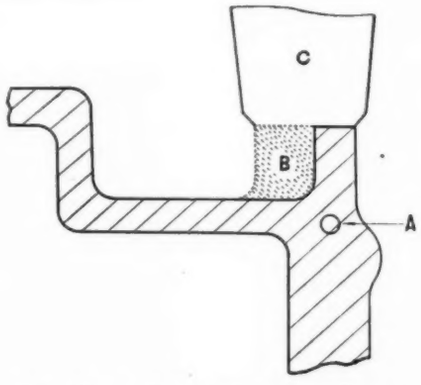

Fig. 109.—A Similar Shrinkage Defect.

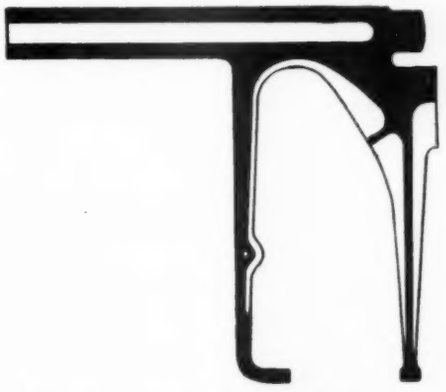

Fig. 115.—A Part Section of Large Casting showing Rod of Metal Cast on it, over 13 ft. Long, 18 in. Diameter.

(Continued from previous page.)

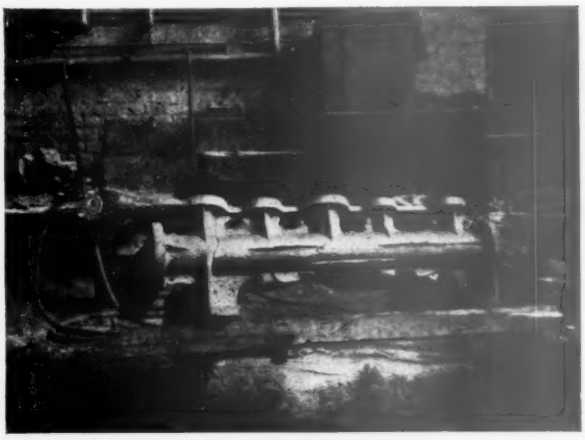

Fig. 100.—Cast Steel Connection Piece With Five Branches and Two Seatings.

Fig. 101.—Close-up of the Defect known as "Hot Tear."

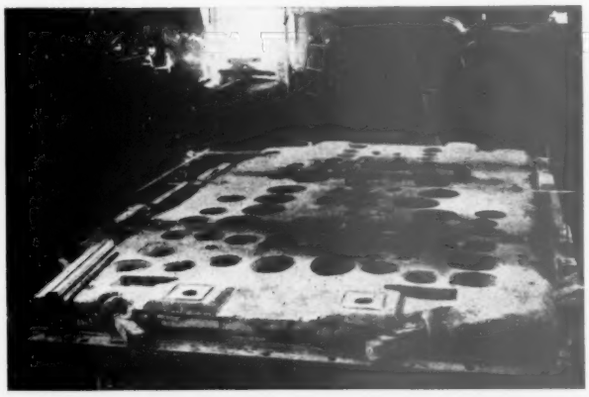

Fig. 104.—Completed Top Half of a Mould for a Large Steel Turbine Casting.

Fig. 110.—Radiograph showing Piping.

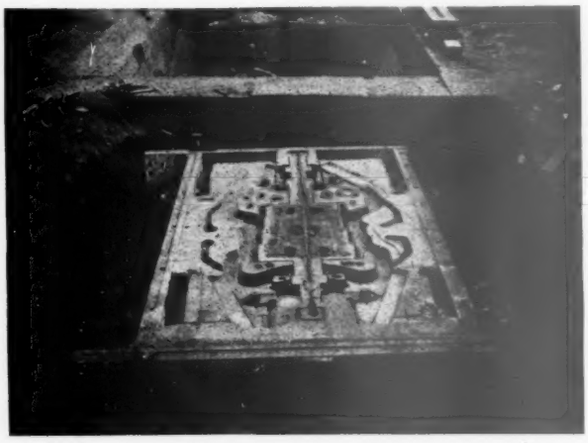

Fig. 105.—Bottom Half Mould for a Top Section of a H.P. Cast-Steel Turbine.

Fig. 106.—Bottom Half Mould for the Lower Section of a H.P. Cast-Steel Turbine.

Fig. 111.—Section of "V" Piping.

Fig. 112.—Typical Shrinkage Defect known in the Foundry as Drawn Metal Defect.

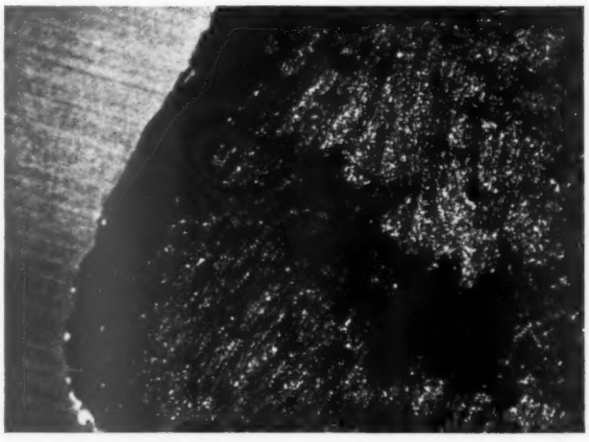

Fig. 113.—Shrinkage Cavity. × 4.

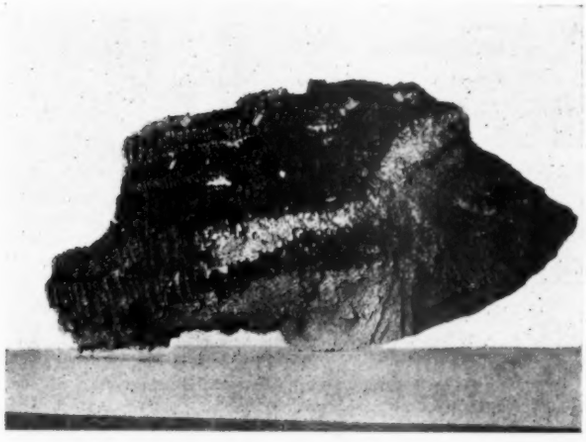

Fig. 114.—Specimen of Steel showing Dendritic Formation.

Fig. 119.—One Side of a Large Turbine Casting with Feeders attached.

Fig. 120.—The other side of the same Casting.

Another defect generally referred to by many overseers as a blowhole, is the drawn cavity, or, to give it the correct term, shrinkage cavity. These cavities occur usually in a part of the casting where the section alters. The defect occurs when the volume of liquid metal changes from the temperature at which it is cast to that at which it is just commencing to solidify.

The foundryman should make good this shrinkage by the use of feeders, which must be

Fig. 116.—Shrinkage Defect in Boiler Stop Valve, shown at A.A.

judiciously placed in correct positions and be of the correct design. The "T"-section piece, Fig. 107, was cut from a steel casting after being radiographed. On being sectioned through A—B, the shrinkage cavity shown at G was found. The design, it will be seen, shows the web of metal at C, 1½ in. thick, and at D, ¾ in. thick; this condition brings about two periods of solidification, *i.e.*, section D cools before C, and the shrinkage defect at G, naturally occurred, owing to no feeder having been used.

To eliminate this defect, the moulder would thicken up section D on the upper side as cast, as shown in the shaded portion at E; the alteration would then allow him to add a feeder at F, which would be effective.

The two pieces of metal in Fig. 108 are bosses, one cut from a vertical wall as cast, and the other from a plate of metal over a core. They were both taken from a casting which had been radiographed. The cavity shown in the vertical piece as cast is again a shrinkage defect caused through the change in section. This could be eliminated by carrying through a piece of extra metal as shown at C, and placing a feeder over the part. The other piece, which was taken from the plate of metal over the core, was found to be sound, as it was in a horizontal position when cast. In addition, a boss in the position shown can be fed by a feeder as shown at D, without having to add extra metal to the casting as is necessary in the vertical position shown at C.

The defect at A, Fig. 109, would be prevented by adding metal at B, and placing a feeder at C. The radiograph examination of such defects as

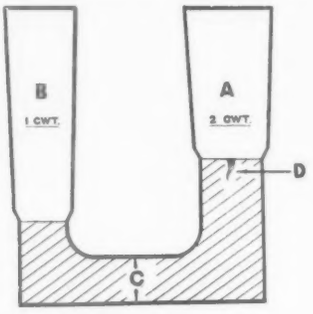

Fig. 118.—Section of Casting (Fig. 117) through Defective Part.

described is shown in Figs. 110 and 111. The section, 1½ in. thick, illustrating shrinkage piping, due to insufficient feeding, is shown in the radiograph. After cutting the section the typical "V" piping is seen here in the actual material, and it will be noted how important it becomes to see that sufficient feeding and good-running arrangements are allowed for, during the early stages of manufacture.

Fig. 112 is that of a casting with a shrinkage defect, and is known in the foundry as drawn metal. The term means that a heavy section somewhere close to the defect has drawn away the metal. It indicates how important it is for the foundryman to examine each defect and correctly diagnose before attempting to remedy it. This defect is really due to shrinkage, and is not in any way associated with the blowhole defect.

Shrinkage cavities are produced during the cooling of the metal through the plastic range, and result from a deficiency of molten metal to feed the point concerned. Such cavities are not smooth as in the case of blowholes, but usually show a dendritic surface (Fig. 113). This formation is a result of the natural tendency of all metals to produce branches of crystal growth. It, however, is impossible under perfect conditions owing to adjacent crystals impeding one another.

Fig. 114 is that of a specimen of steel showing dendritic formation, the piece being broken from the inside of a feeder. As a matter of interest, the sample is a particularly good illustration of a dendrite.

The specification for the casting shown in Fig. 115 was that a 9-in. hole or core had to be drilled or cast down the rod for lightening pur-

Fig. 117.—Shrinkage Cavity under Feeder.

poses. The only safe method in the foundry to get a sound casting, was to cast the rod solid, so that feed could be supplied to adjoining thick sections. This method was carried out and a feeder was added 13 ft. 6 in. long, resulting in a perfect casting. A cheaper casting could have been produced by using a core, but shrinkage defects would have been almost certain to develop in the heavy junctions.

The feeders on the two defective faces shown in Fig. 116 were placed on the side of the casting in this instance on account of bosses, where the defects are seen, being placed at an angle in the design. In instances of this kind, it is considered the best practice to add sufficient height of feeder above the top of the casting (as cast), so as to obtain gravity pressure to hold up sections adjoining the bosses until they solidify. A shrinkage cavity, shown in Fig. 117, under one of the feeders which has been removed. This casting has another feeder close to the one show-

(*Continued on page* 280.)

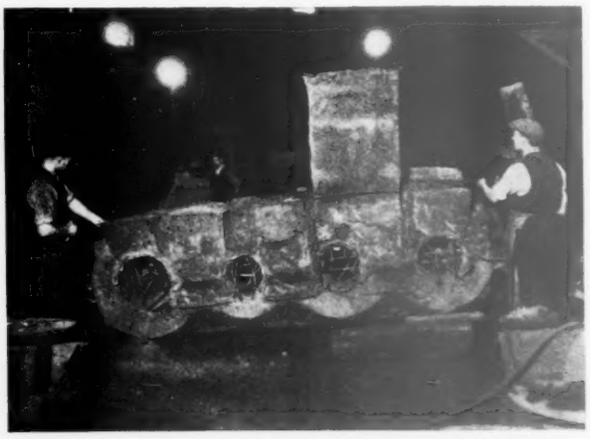

Fig. 121.—Large Valve for the same Turbine Set.

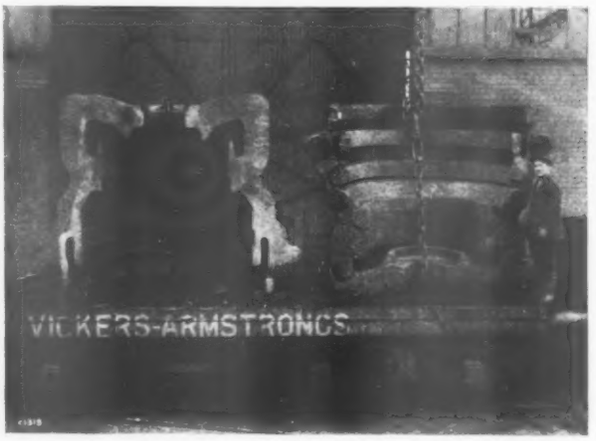

Fig. 122.—Land-Turbine Castings.

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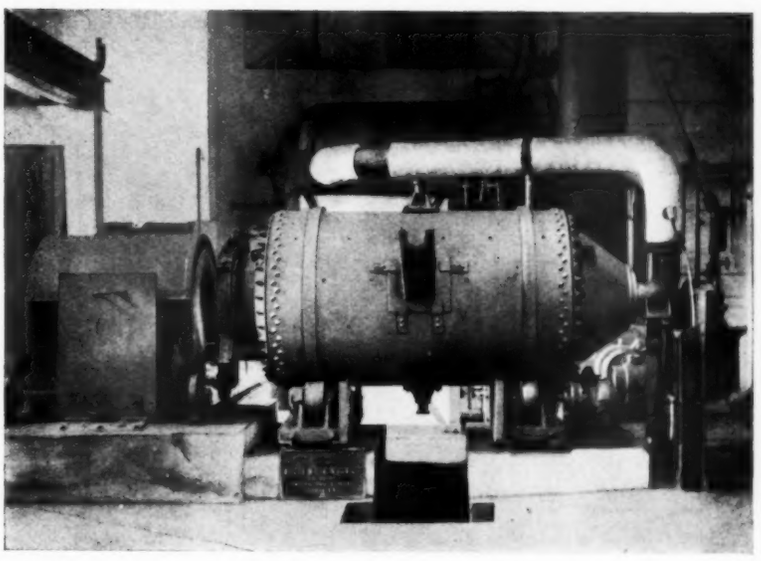

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Malleable Furnace Refractories*

By L. C. HEWITT,† St. Louis, Mo., U.S.A.

Bung Brick

The improvement in bung-brick manufacture has been one of increased refractoriness, greater density for resisting slag action, and a structure that meets to a better degree various types of spalling, namely, structural, thermal, and mechanical. In respect to application, some work has been done toward the idea of using a spring arrangement in the bung head, arranged in such a manner that the brick will be kept tight in the bung and, at the same time, allow for expansion to be taken up without causing pinching action.

With the conventional type of bung, the best practice seems to be to tighten the bung thoroughly as it is laid, and take up any further slack at each heat after the furnace is up to full temperature. The use of a lubricant that will not be affected unduly under temperature, such as a small amount of kerosene in the grease used for oiling the bolt heads, aids in keeping them free and workable when subjected to the heat of the furnace.

The life of bung brick varies considerably from plant to plant, both in respect to the number of heats and the amount used per ton of metal. The performance depends on a great many factors, such as laying practice and temperature of operation, distance between the bath and bung roof, width of furnace, bung rise, etc. The situation is such that it is very difficult to correlate service from plant to plant in order to determine fully why there is such a wide variance in the furnace life on the same type of brick. One of the chief destructive forces is the mechanical action to which the bungs are subjected during the charging process. At best, the operation is such that the bung-brick edges are often severely damaged.

Bung Removal Practice

In some plants, the practice of removing the charge bungs is to place them over the end furnace bungs, while, in other cases, as they are removed they are placed on the furnace-room floor. The latter procedure would seem to be the most favourable, from the standpoint of the charge bungs receiving less mechanical shock and avoiding the heating of the stationary bung frames. The charge bungs, as removed, contain sufficient heat when placed over the frames of other bungs to cause the latter often to get out of shape and to allow the brick in the frame to become loose.

The use of an extra taper represents a development in bung-brick design. This extra taper is varied to permit of an open joint from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. to allow for the expansion that takes place in the hot face of the bung brick, and thus lessens spalling action due to pinching. The open joint terminates or converges to a point $1\frac{1}{2}$ in. from the brick face. The desirable joint width seems to vary somewhat between plants. Further application will, no doubt, result in a more standardised practice.

The idea of laying up this extra or double-tapered brick with a dipped joint and then washing or slushing the surface, in order to fill up the purposely-formed joints either with a regular type of foundry clay or a special high-temperature mortar, indicates an advantage. The question may be asked: "Why allow for a joint and then fill it up?" The answer seems to be that the clay or mortar will provide a cushion, as it were, at the joints and also reduce flame-cutting action. The use of special high-temperature mortar for laying and washing bung brick in general is also gaining in favour.

Side Wall, End Wall and Bridge Wall

First-quality stiff-mud firebrick has been the major product used in malleable-wall construction. This type of brick has been improved in recent years, particularly in respect to its density and resistance to thermal shock.

A type of brick finding application in side walls, front wall and bridge wall is that of the superheat-duty fireclay brick class. This type of brick, while not having the mechanical strength that the stiff-mud variety has, works out very well in practice, particularly because of the vitreous protection layers that form in usage. Bricks of the superheat-duty type have a relatively high density, constancy of volume under high temperatures, and high resistance to thermal shock, qualities which, together with refractoriness, account for the generally improved service rendered. With this type of brick, the best practice is to use a special high-temperature mortar as recommended by the manufacturer. Sufficient amount of such mortar should be used to fill well all of the joints; in fact, this practice of filling the joints and the use of highly refractory laying mixture should be most economical in most malleable furnaces.

The use of superheat-duty fireclay brick in malleable-furnace side walls has not, in every instance, proved its value, due to differential first cost. Its greatest advantage seems to be in those furnaces that have the most severe operating conditions. Further, plants which are equipped with "standby" furnaces and can run a side wall until its full life is completed and do not have to repair every week-end, are also better situated for taking advantage of extra heats that bricks of this type will produce.

Tap-Out Block

Tap-out blocks, of a specially dense superheat-duty fireclay-brick class, are proving of particular advantage in many applications. The life secured is not only longer, but the metal stream is better controlled, and, in addition, there is the added assurance against the loss of a heat because of tap-out block failure.

Malleable Foundry Bottoms

There is a rapidly-growing tendency toward the use of firebrick bottoms. This tendency is, no doubt, due principally to the fact that firebricks are now available which do not shrink and allow the metal to enter the joints and float the bricks out. The type of brick used has been of the superheat fireclay brick and 60 per cent. alumina classes. While it has not apparently been definitely settled which one of these two types are the most economical in all cases, it appears that, all factors considered—price differential and life secured—superheat-duty fireclay brick will be standardised for use.

The bottom should be laid with a highly-refractory cold-set cement, in view of the fact that this type of joint will be sealed all the way through and form a monolithic type of construction. The brick are laid on end, that is, the bottom will be 9 in. in thickness. The practice varies in regard to forming an arch, inverted arch, and straight or flat brick bottom. The straight or flat bottom, tied in under the side walls with some space allowed for expansion, would, at this time, appear to be best practice.

* Paper presented to the Annual Meeting of the American Foundrymen's Association.

† Director of Research, Laclede-Christy Clay Products Company.

Castings

(*Continued from page* 278.)

ing the defect, which it will be noted is less in size. It has been found that two feeders close together of different sizes, similar to the two shown, cause a defect of this kind, especially when the casting thickness between the feeders is approximately the same thickness as the parts being fed. This is due to the metal in the larger feeder on the high part of the casting supplying feed to the feeder on the lower face of the casting. This defect would be eliminated by removing the smaller feeder, leaving the larger one to feed the casting.

In the feeding of castings, the supervisor in the foundry must give every job very careful thought before deciding the procedure, as badly positioned feeders, and those of unsatisfactory design, cause a high percentage of defective castings. Many serious defects come from this section of the moulder's work, and the placing of runners to get hot metal in the feeders is important, so that it can supply a flow of metal to the parts which solidify last.

In Fig. 118 can be seen the shrinkage cavity, such as was shown in Fig. 117. It is shown at D, under feeder A. Feeder B was eliminated on account of feeder A being sufficient, in view of the section at C being equal in thickness to the part under B. It is better practice in instances of this kind to use one feeder on the high flange, but it is necessary to take careful note of section C, as the thickness here controls the decision, as, if this thickness were less, two feeders would be necessary. Such is the decision that has to be made by the supervisor before commencing to manufacture.

Having described some of the causes of shrinkage defects in steel castings, a few pictures of castings with feeders attached, might be of interest. The flanges of the casting, shown in Fig. 119, were 10 in. thick, and the body thickness 3 in. Ten feeders were used, the height of which was greater than the depth of the casting.

The weight of the metal used in feeders shown in Figs. 119 and 120 was approximately 12 tons, the casting as delivered being only 7 tons.

The casting illustrated in Fig. 121 had ten feeders attached, one of which can be seen cut through, but not removed from the casting. The position of the remaining nine were between each of the inlets of the valve, in order to feed without any obstruction by the core, which cuts through on the face of each side of the valve. This particular casting took over 20 tons of metal to cast, and the valve when delivered weighed only 8 tons.

To obtain quality in steel castings of this description, the only method which has proved effective in eliminating shrinkage defects is that of using feeders of sufficient size to deal with the heavy sections of metal in the design. The cost of removing such feeders is obviously high, and buyers of steel castings who require the best article should bear this in mind, as sound castings of this description cannot be produced unless a large quantity of metal be used above the finished weight of the casting. Cast-steel land-turbine pieces, shown in Fig. 122, were dealt with on these lines, and satisfactory results were obtained only by observance of the methods indicated.

(*To be Concluded.*)

MESSRS. ANDREW STRANG & COMPANY, LIMITED, point out that the note concerning a "giant" propeller which appeared in our issue of September 26 was an exaggeration, and that they as a firm disclaim that the propeller in question had special features as to either weight or surface areas, or that they were responsible for the issue of the item. We regret that we gave it publicity.

WM. CUMMING & CO. LTD.

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Ironfounders' Facings Manufacturers and General Foundry Furnishers,

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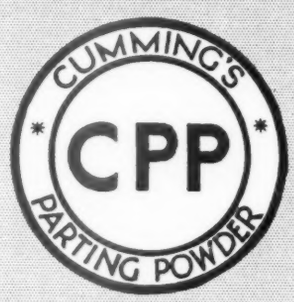
SUPERFINE COAL DUST

SUPERLATIVELY REGULAR IN GRIST.
SUPERIOR IN QUALITY.
SEVEN GRISTS STANDARDISED.
ONE QUALITY OF COAL THROUGHOUT.



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CORE COMPOUNDS, PARTINGS, CUMMINGSTONE, REQUISITES, BLACKINGS for every PURPOSE

ALL OUR OWN MAKE

This Week's News in Brief

Trade Talk

AT THE LAST MEETING of the Falkirk Dean of Guild Court Messrs. R. & A. Main, Limited, Gothic Iron Works, were granted permission to erect a new cupola platform and roof in their foundry premises.

MESSRS. FAWCETT, PRESTON & COMPANY, LIMITED, of Liverpool, are erecting new workshops, planned with a view to greater developments in the future, as trade continues to improve. The new works include a brassfoundry.

THE WHESSOE FOUNDRY & ENGINEERING COMPANY, LIMITED, Darlington, have secured the contract for the construction of the additional 1,500,000-gall. oil-storage tank to be built at the Shell Mex and B.P. depôt at Jarrow.

WAGES OF Scottish ironworkers will be increased by 2½ per cent. in consequence of the higher selling price of iron during July and August. Intimation has been made by the auditors that the average net selling price was £9 12s. 9.62d.

MESSRS. LOBNITZ & COMPANY, LIMITED, Renfrew, have received orders to build a grab hopper dredger and a bucket dredger for British owners. The orders will, with work in hand, maintain the works in full employment for some time.

THE FEDERATION OF BRITISH INDUSTRIES announces that a Mission will leave for Warsaw on November 2 to follow up and take full advantage of the benefits offered to this country by the Anglo-Polish Agreement signed on February 27, 1935.

THAT THERE IS a growing scarcity of scrap iron in the Irish Free State was revealed this week when the Free State Prices Commission held a sitting to inquire into the prices of foundry work used in the building of new houses throughout the country.

MESSRS. NEWALL'S INSULATION COMPANY have secured the contract for the entire insulation of the "Queen Mary." The contract includes the insulation of 26 boilers, 16 turbine casings, all the main and exhaust steam piping and the shipyard pipe lines.

MESSRS. RONALD TRIST & COMPANY, LIMITED, engineering specialists, have removed from 56, Victoria Street, Westminster, S.W.1, to 1-3, Brixton Road, London, S.W.9. They have also brought their works from Watford into close proximity to the new offices.

MESSRS. JOHN BROWN & COMPANY, LIMITED, Clydebank, have secured an order from the New Zealand Shipping Company, Limited, for two cargo vessels each of 11,000 tons gross. The propelling machinery will consist of six-cylinder Diesel engines supplied by the builders.

MESSRS. HURST, NELSON & COMPANY, LIMITED, Motherwell, have secured a contract from the Assam-Bengal Railway for an order of 30 wagons comprising 20 metre-gauge petrol-tank wagons each with a capacity of 5,500 galls. and 10 metre gauge four-wheeled oil-tank wagons of 2,800 galls. capacity each.

LAST WEEK an innovation in local steelworks practice was introduced at Messrs. Colvilles Dalzell works, Motherwell. The large mill was kept in operation until 5 o'clock on Saturday afternoon. This new departure is due in part to an extra rush of work in the department, but mainly with the idea of using up the hot metal from the final casts on Saturdays.

THE PARTNERSHIP between Messrs. William Fletcher, Harold Ellis, William Lounds Winterton and Ernest Owen Ellis, carrying on business as iron and brass founders, at Alfred Street North, Nottingham, under the style of Fletcher Foundry Company, has been dissolved. Messrs. William Fletcher and Harold Ellis are continuing the business in partnership under the same style.

MR. COLVILLE, Secretary to the Department of Overseas Trade, speaking at Shandon, Dumbartonshire, last week, referred to the recent improvement in the employment returns. In illustration of the decrease in the number of unemployed in various industries during the past year he cited, among others:—Miners, 51,000; engineers, 13,000; iron and steel workers, 11,000; and shipbuilders, 8,000.

THE SINGER COMPANY, Clydebank, have secured a substantial order from the Government for sewing machines and accessories. The sewing machines are of the heavy type used in the manufacture of boots and clothing, and the company will be able to proceed with the order at once, having all the necessary plant in readiness. Some of the departments which have been on short time will be put on a full working week to cope with the order.

Personal

MR. A. H. GILLING, M.Inst.C.E., M.I.Mech.E., has been appointed general manager of Messrs. R. Y. Pickering & Company, Limited, wagon builders, Wishaw.

MR. F. M. MORRIS has been appointed vice-chairman and managing director of Herbert Morris, Limited. MR. GEORGE MACBRIAR and MR. H. G. PURNELL have been appointed directors of the company.

MR. JOHN MASON has retired after 54 years' service with the Cannon Iron Foundries, Limited, Deepfields, Bilston, the last 38 years in the capacity of secretary. He is succeeded by Mr. Edward J. Bryden.

MR. P. G. CORIN has been appointed technical director of Messrs. Henry Berry & Company, Limited, hydraulic engineers, Leeds. Mr. Corin was previously with Imperial Chemical Industries, Limited, at Billingham-on-Tees.

MR. J. W. REANEY has been appointed commercial manager and MR. E. E. PAYNE technical manager of the machinery department of Messrs. Edgar Allen & Company, Limited. MR. GEOFFREY H. N. COLES has been appointed engineer representative of the department.

MR. JOHN D. TOMLINSON, chairman of directors of Tomlinsons (Rochdale), Limited, Soho Iron Works, Rochdale, and Mrs. Tomlinson celebrated their golden wedding on Friday, when between six and seven hundred members of the staff and employees of the firm and their wives and friends were entertained in the Carlton Ballroom, Great George Street, Rochdale.

Company Reports

Stewarts and Lloyds, Limited.—Interim dividends for the half-year ended June 30, 1935, at the rate of 6 per cent. per annum on the cumulative first preference shares, at the rate of 10 per cent. per annum on the cumulative second preference shares and at the rate of 5 per cent. per annum on the cumulative third preference shares, to be paid on October 31.

John Brown & Company, Limited.—The directors have decided to pay an interim dividend on the 7 per cent. non-cumulative "A" and "B" preference shares in respect of the half-year ended September 30, 1935. The preference capital in its present form dates from 1930, when a reorganisation scheme was carried through. The dividend now declared is the first since the reorganisation.

Platt Bros. & Company (Holdings), Limited.—The directors have intimated that they anticipate being able to pay another year's arrears of dividend on the first preference shares in December, 1935. When this payment has been made, all arrears of dividend on the first preference shares will have been paid. Dividend warrants have been posted in payment of a full year's dividend on the 4½ per cent. first preference shares, which clears arrears to September, 1934.

Contracts Open

St. Neots, October 18.—14 miles of cast-iron or spun-iron water main, 5 in. to 3 in. dia., for the Rural District Council. Messrs. Pick, Everard, Keay & Gimson, 6, Millstone Lane, Leicester. (Fee £2 2s., returnable.)

Kislingbury, October 15.—Surface pumping plant and accessories, and sectional pressed steel elevated reservoir of 9,600 galls. capacity, for the Northampton Rural District Council. Mr. R. J. Miller, 20, The Millway, Duston, Northampton.

Bradford, October 14.—Sewage ironwork comprising sluice valves, disc valves, penstocks and floating outlet arms, and 65 tons of cast-iron troughing, for the Town Council. Mr. H. Wontner-Smith, sewage works engineer, Esholt Hall, near Shipley. (Fee £1 1s., returnable.)

Uckfield, October 9.—Eight miles of 4-in. and 3-in. spun-iron pipes, with valves, etc., and erection of a small pumping station, collecting tanks and incidental works, and provision and erection of duplicate electrically-operated boosting equipment; also provision and erection of aeration plant and gravity filter, for the Uckfield Rural District Council. The Surveyor, "Starfield," Beacon Road, Crowborough. (Fee £3 3s., returnable.)

Obituary

MR. THOMAS SWINNEY, chairman of Messrs. Swinney Bros., Limited, Wansbeck Ironworks, Morpeth, died last week after a short illness. He was in his 70th year.

MR. MAURICE LEES, managing director of H. Lees & Sons, Limited, Parkbridge Ironworks, near Ashton, died recently. Mr. Lees made many generous gifts to charity, and for half a century was Mayor of the Manor of Ashton.

MR. ROBERT DUNLOP, who died suddenly last week, in his 81st year, started work in the old malleable-iron works at Motherwell, and later went to the Dalzell works, where he remained for over 50 years, finally retiring from the position of sample passer some years ago. He was a life-long friend of the Rt. Hon. John Hodge, with whom he was associated in employment at Dalzell Works. Mr. Dunlop visited Germany many years ago, at the request of the late Mr. David Colville, for the purpose of studying steelmaking methods there. He was also selected by a well-known Scottish newspaper to visit America to inquire into steelmaking organisation and conditions in the United States. Mr. Dunlop was for many years President of the local Steel Smelters' Association.

MR. JAMES PEECH, one of the best-known figures in the steel industry in this country, died on Monday. Mr. Peech, who was 62 years of age, had been connected with the manufacture of steel since he was 19. He was the son of the late Mr. William Peech, one of the original founders of Steel, Peech & Tozer, Limited, and was a director of that company; later he became a director of the United Steel Companies, Limited. Mr. Peech was particularly well known in the railway world, and had travelled extensively on behalf of the United Steel Companies, Limited, on railway business, particularly in Canada, China, South Africa and Egypt. During the war he was adviser on shell steel to the Ministry of Munitions, and was awarded the C.B.E., and also a French decoration.

New Company

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

L. E. Stanley, Limited, 13B, High Road Kilburn, London, N.W.6.—Capital £100. Ironfounders, mechanical engineers, etc. Directors: Sylvia Gordon-Stewart, L. C. Stanley and W. E. G. Stanley.

Forthcoming Events

OCTOBER 14.

Sheffield Society of Engineers and Metallurgists and Sheffield Metallurgical Association:—Joint meeting with the Iron and Steel Institute to discuss a selection of Papers presented at the recent autumn meeting of the Iron and Steel Institute, to be held in the Mappin Hall, St. George's Square, Sheffield, from 3 p.m. onwards.

Institute of British Foundrymen

OCTOBER 12.

Scottish Branch:—(1) Presidential address; (2) "Some Notes on Using Metal Moulds for Cast Iron," Paper by J. McGrandle at the Royal Technical College, George Street, Glasgow, at 4 p.m.

OCTOBER 18.

Middlesbrough Branch:—"A Talk on the Production of Steel Castings," Paper by J. G. Wrightson, at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7.45 p.m.

Sheffield and District Branch:—"System in the Selling of Castings," Paper by E. N. Simons, at the Grand Hotel, Sheffield, at 7.30 p.m.

OCTOBER 19.

Falkirk Section:—(1) Presidental address; (2) "Moulding-Shop Problems," Paper by W. McArthur at the Temperance Café, Lint Riggs, Falkirk, at 6 p.m.

Lincolnshire Section:—"Recent Developments in Foundry Practice," Paper by L. W. Bolton, A.M.I.Mech.E., at the Technical College, Monks Road, Lincoln, at 7 p.m.

Newcastle-upon-Tyne and District Branch:—Visit of Council of the Institute.

The Institute of Vitreous Enamellers

OCTOBER 17.

Birmingham:—"The Development of a Continuous Vitreous Enamelling Furnace," Paper by W. Marshall, of the Ferro Enamelling Company (England), Limited, at the Chamber of Commerce, New Street, Birmingham, at 7.30 p.m.

XUM

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CONTINUOUS SAND MIXER

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Raw Material Markets

There has been a decrease in the amount of foreign trade this week, but the demand from home sources has shown a further rise. Rumours of an increase in prices have acted as a stimulus to buyers, who are desirous of covering before any alteration comes into force. Blast-furnacemen and steelmakers are well employed, and orders already received amount to a large tonnage. Six new tankers have recently been ordered, and further encouragement is given to the heavy industries by the invitation of tenders for new naval vessels. Discussions between the Bristol Iron and Steel Federation and the Continental Steel Cartel were resumed in London last week, and consideration of the allocation of the British export quota as between the various divisions of the industry was begun.

Pig-Iron

MIDDLESBROUGH.—The quantity of iron delivered this week has been in excess of new business placed. This was expected, and the position of furnacemen is quite satisfactory, for they have very little surplus iron for sale this year. The export trade continues to be in a lifeless condition, but the home demands make ample amends for that. Scottish foundries are still taking up satisfactory tonnages of Cleveland pig-iron. Prices are unchanged, the fixed home minima for No. 3 Cleveland G.M.B. being 67s. 6d. per ton delivered Middlesbrough, 69s. 6d. delivered North-East Coast, 67s. 3d. delivered Falkirk, and 70s. 3d. delivered Glasgow.

The output of ten blast furnaces which are producing hematite in this area is not too much to satisfy the requirements of consumers, and stocks are not increasing. Local steel plants are taking up a large proportion of the output. Trade with Italy continues to be suspended, but exporters have an outlet to Denmark, which is taking good quantities. Delivered prices are as follow:—Middlesbrough, 71s. per ton; Tyneside, 72s.; North-East Coast, 73s. 6d.; Scotland, 74s.; Sheffield, 78s. 6d.; Midlands, 84s. 6d. per ton.

LANCASHIRE.—Satisfactory tonnages of pig-iron are being taken up in this district, although the requirements of the light-castings founders are showing a slight decrease on recent demands. The needs of the textile-machinery makers have expanded and the demands of general engineers are good. The position of the machine-tool manufacturers is still encouraging, but the jobbing foundries are continuing to be affected by poor prices, although their condition has improved a little. Prices are firm, and for delivery to consumers in the Lancashire area, Staffordshire, Derbyshire and Lancashire brands of No. 3 iron equal to Derbyshire are all quoted at 74s. per ton, with Northamptonshire at 72s. 6d., and Scottish foundry at about 81s. 6d. Hematite is in steady demand and prices are firm, with East Coast qualities ranging from about 80s. to 81s. per ton, delivered equal to Manchester, and West Coast hematite at around 81s.

MIDLANDS.—Although new business is scarce, the condition of the pig-iron trade is satisfactory. Deliveries are heavy, and reports from some places state that September was the busiest month of the year in this respect. The light-castings makers and the general engineering concerns are well employed, and the prospects of these sections of the trade are very hopeful. Prices of ordinary foundry iron delivered to Birmingham and Black Country stations are 67s. 6d. per ton for Northants No. 3, and 71s. for Derbyshire, Lincolnshire and North Staffordshire No. 3. A small graduated rebate is given to large consumers. The state of the demand for better grades of iron is good, and with the approach of winter further expansion will be looked for. Prices are not controlled and vary considerably. Medium-phosphorus iron is on offer at between 72s. and 82s. 6d. per ton, while low-phosphorus is between 85s. and 90s. and refined iron from £5 7s. 6d. to £6 per ton delivered South Staffs. Regular supplies of hematite are being taken against contracts, and prices are as follow:—84s. 6d. for West Coast mixed numbers and 84s. 6d. for East Coast No. 1. These prices include delivery to private sidings or station only. For delivery into works in 10-ton lots a charge of 1s. 6d. per ton extra would be made. East Coast No. 3 hematite has been reduced to 83s. 6d., and the price of Welsh mixed numbers is 83s. per ton delivered stations.

SCOTLAND.—Hematite and basic irons are being consumed in large quantities in this area, and the majority of buyers are well covered. Prices are unchanged, and the official minimum of 70s. at furnaces for No. 3 is maintained, No. 1 being 2s. 6d. per ton extra. Export conditions show an improvement, but they are still poor. The light-castings makers are taking good deliveries against contracts. The official quotations for No. 3 Cleveland iron are unaltered at 67s. 3d. per ton at Falkirk, and 70s. 3d. at Glasgow; other English foundry iron is at 1s. 3d. per ton less. Steel-making irons continue to be in good demand by local steelworks, and quotations are as follow:—Mixed numbers Scottish hematite, 71s. to 73s. 6d.; mixed numbers West Coast hematite, 74s.; ordinary mixed numbers East Coast hematite, 74s.; basic, British and Indian, 70s., less 5s. rebate, all delivered local steelworks.

Coke

Most of the coke consumers are well covered for their winter requirements, and as a result new business is not easy to obtain. For delivery in Birmingham and district best Durham coke ranges from 37s. 6d. to 40s., and other qualities are quoted down to 34s. per ton. Welsh coke is at from 31s. 6d. to 43s. 6d., and Scottish low-ash coke at around 40s. per ton.

Steel

With the opening of the last quarter of the year, increasing business activity has developed in the steel market, and in several departments the producers are extending the periods in which they can give delivery, says the official report of the London Iron and Steel Exchange. The demand is developing steadily and, although the orders reaching the steelworks are not individually large, there is a tendency for the weights to increase. The situation in the semi-finished steel department is satisfactory, and many of the producing works are operating at capacity New business is active, and there is considerable pressure on the part of consumers to obtain delivery. Most of them have important running contracts; but an important business is passing in small supplementary parcels. In the finished-steel section some irregularity is noticeable in the volume of new business. To a great extent this is due to important users having covered their requirements for some time ahead. Specifications are reaching the works on a satisfactory scale, however, and the general tendency is for the demand to expand.

Scrap

In spite of a heavy demand for most descriptions of iron and steel scrap in the Cleveland area, prices are unchanged. Good heavy melting steel at 52s. 6d. per ton delivered works is in good call, and ordinary heavy foundry metal is at 52s. 6d. per ton. Machinery cast-iron scrap is a steady market at 54s., with light metal at 42s. 6d. per ton. The Midland market is active, and there is a good inquiry for all qualities of scrap. Heavy steel in furnace sizes is at 45s. to 46s., and mixed heavy iron and steel is at 43s. 6d. to 44s. 6d. per ton Cast-iron scrap has a steady demand, and prices are firm. Heavy machinery metal in handy sizes is on offer at 55s. to 57s. 6d., while good heavy is at 50s. and clean light at 47s. 6d. The price of short, heavy, steel scrap as used in the foundries is 55s. per ton delivered works. The condition of the Lancashire market is satisfactory, and prices are firm. Good machinery cast-iron scrap is at from about 50s. to 55s. per ton, according to grade and the situation of supplies, and inclusive of delivery to Lancashire foundries. Business on the Yorkshire market is strong, with a good demand for most classes of scrap material. Prices are firm, and should there be an increase in consumers' requirements, a rise in prices will almost certainly follow. Heavy basic steel is being well taken up by steel makers, and is at about 52s. 6d. delivered, but the general figure is lower than this. Mixed iron and steel is at 52s. to 52s. 6d. per ton delivered, and light basic steel is at 43s. Foundry cast iron is in good demand at from 51s. to 55s. per ton. In Scotland, good machinery cast-iron scrap, in pieces not exceeding 1 cwt., is at 56s. 6d. to 57s. 6d., with ordinary cast iron, to the same specification, about 5s. less, steelworks' cast iron in furnace sizes at 50s., and light cast iron at 45s., delivered consumers' works.

Metals

Copper.—This market is in a very sound position. The demand for industrial purposes is good, while war news has been responsible for much additional activity. Reports from New York state that there will be a conference in London or Brussels shortly of copper producers, when the question of contemplated large orders for Italy, which are said to amount to 60,000 tons over next year, will be considered. In the United States market the domestic quotation for electro copper has been raised to 9.4 cents per lb. delivered Connecticut Valley. Sales of domestic copper during September are given at over 85,000 short tons.

Daily market prices :—

Cash.—Thursday, £35 5s. to £35 6s. 3d.; Friday, £35 13s. 9d. to £35 15s.; Monday, £36 6s. 3d. to £36 7s. 6d.; Tuesday, £35 12s. 6d. to £35 13s. 9d.; Wednesday, £35 16s. 3d. to £35 17s. 6d.

Three Months.—Thursday, £35 11s. 3d. to £35 13s. 9d.; Friday, £36 1s. 3d. to £36 2s. 6d.; Monday, £36 13s. 9d. to £36 15s.; Tuesday, £35 18s. 9d. to £36; Wednesday, £36 3s. 9d. to £36 5s.

Tin.—An irregular tone has been apparent in this metal. The meeting last week of the International Tin Committee had a disturbing influence on the market. After the meeting it was announced that it was decided to recommend to the signatory governments that the quota of production should be fixed at 70 per cent. of the standard tonnages. This increase is retrospective from July 1, 1935. The United States demand is good and business is generally quite satisfactory. The same remarks may also be applied throughout the remainder of the world.

Day-to-day fluctuations :—

Cash.—Thursday, £224 15s. to £225; Friday, £221 10s. (no sellers); Monday, £227 10s. to £228; Tuesday, £228 to £228 10s.; Wednesday, £229 5s. to £229 10s.

Three Months.—Thursday, £215 5s. to £215 10s.; Friday, £214 to £214 5s.; Monday, £219 10s. to £219 15s.; Tuesday, £219 5s. to £219 10s.; Wednesday, £219 10s. to £220.

Spelter.—The price of spelter is now around the highest level of the year. The galvanised-sheet and wire trade is consuming very little spelter, and this factor is a drawback to the general improvement in the metal. Brass manufacturers are well employed and are taking up satisfactory quantities of spelter. In the United States the industrial demand is good, as it is on the Continent, where producers are stated to be well sold.

Official quotations were as follow :—

Ordinary.—Thursday, £16 8s. 9d.; Friday, £16 17s. 6d.; Monday, £17 6s. 3d.; Tuesday, £16 17s. 6d.; Wednesday, £16 15s.

Lead.—The position of this metal is very sound and prospects are encouraging. Supplies are short and the demand is good. English cable manufacturers are continually in the market for good quantities of lead. It is expected that prices will go still higher if the present demand continues, and there is no reason to suppose that it will not become even greater.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £17 17s. 6d.; Friday, £18 12s. 6d.; Monday, £19 15s.; Tuesday, £19 1s. 3d.; Wednesday, £19 2s. 6d.

Iron and Steel Production

The British Iron and Steel Federation, in its Statistical Bulletin for August, 1935, states pig-iron production in the United Kingdom in August was 543,400 tons, compared with 547,300 tons in July and 503,300 tons in August, 1934. The pig-iron production for the first eight months of the year is 8.5 per cent. greater than in the corresponding period of last year. Steel production in August was 759,900 tons compared with 803,300 tons in July and 667,000 tons in August, 1934. The production for the first eight months is 8.0 per cent. greater than for the corresponding period of last year. According to returns received from 147 firms employing 120,719 workpeople, the average weekly earnings per head in July amounted to £3 2s. 7d. compared with £3 in June and £3 1s. 8d. in May.

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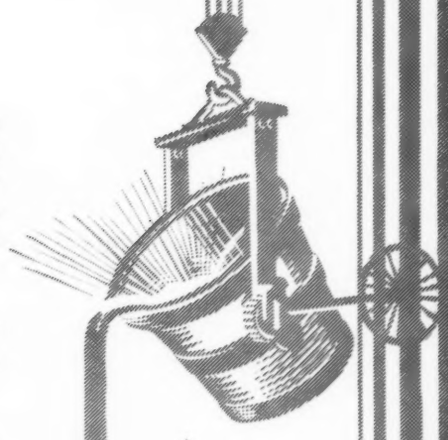
MOULDING BOXES

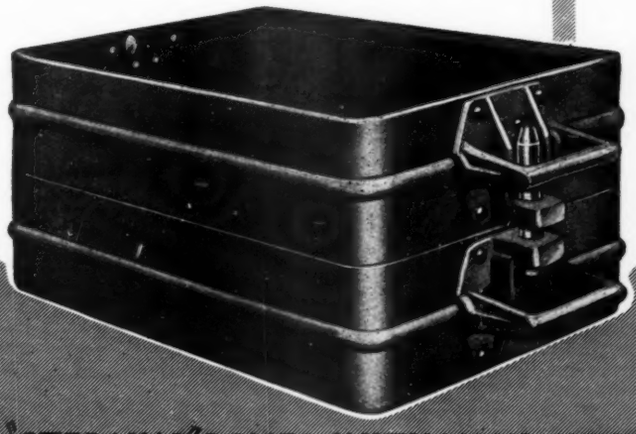
... are designed for the modern foundry

One of the greatest improvements you can introduce into your foundry is the STERLING ROLLED STEEL MOULDING BOX . . . the result is speed and economy all round. Your moulders will put down more moulds per day because of the light and easy handling properties of these boxes.

You will be sure of producing accurate castings because STERLING BOXES maintain their accuracy permanently.

Sterling Boxes—Save their cost in a few months, and are obviously a sound investment for any foundry.





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STERLING WORKS **BEDFORD**

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RAW MATERIALS—PRICE LIST

(Wednesday, October 9, 1935)

COPPER

	£ s. d.
Standard cash	35 16 3
Three months	36 3 9
Electrolytic	40 0 0
Tough	38 5 0
Best selected	38 15 0
Sheets	68 0 0
India	50 10 0
Wire bars	41 0 0
Ingot bars	41 0 0
H.C. wire rods	44 10 0
Off. av. cash, Sept.	34 1 5½
Do., 3 mths., Sept.	34 9 5½
Do., Sttlmnt., Sept.	34 1 6½
Do., Electro, Sept.	38 4 10½
Do., B.S., Sept.	37 9 4½
Do., wire bars, Sept.	38 10 8½
Solid drawn tubes	10½d.
Brazed tubes	10½d.
Wire	6½d.

BRASS

Solid drawn tubes	9¾d.
Brazed tubes	11¾d.
Rods, drawn	8¾d.
Rods, extd. or rlld.	8¾d.
Sheets to 10 w.g.	8¼d.
Wire	7¾d.
Rolled metal	7¾d.
Yellow metal rods	4¼d
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d

TIN

	£ s. d.
Standard cash	229 5 0
Three months	219 10 0
English	229 10 0
Bars	230 10 0
Straits (nom.)	229 15 0
Australian (nom.)	229 15 0
Eastern	225 7 6
Banca (nom.)	230 5 0
Off. av. cash, Sept.	224 3 3½
Do., 3 mths., Sept.	212 12 4½
Do., Sttlmt., Sept.	224 2 7½

SPELTER

	£ s. d.
Ordinary	16 15 0
Remelted	16 0 0
Hard	13 15 0
Electro 99.9	19 7 6
English	17 17 6
India	15 0 0
Zinc dust	19 10 0
Zinc ashes	3 5 0
Off. aver., Sept.	15 10 3½
Aver. spot, Sept.	15 8 3½

LEAD

	£ s. d.
Soft foreign ppt.	19 2 6
Empire (nom.)	19 16 3
English	21 0 0
Off. average, Sept.	16 5 9½
Average spot, Sept.	16 5 2½

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	25 10 0
Do., V.M. ex-whse.	26 10 0
Rods	30 0 0

ANTIMONY

	£ s. d.
English	79 0 0 to 80 0 0
Chinese, ex-whse.	68 0 0
Crude, c.i.f.	34 0 0

QUICKSILVER

	£ s. d.
Quicksilver	11 0 0 to 11 10 0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	8 17 6
45/50%	12 15 0
75%	17 17 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£18 0 0 to £20 0 0
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	33 0 0
4/6% car.	21 15 0
6/8% car.	21 0 0
8/10% car.	21 0 0
Ferro-chrome—	
Max. 2% car.	34 0 0
Max. 1% car.	36 5 0
Max. 0.70% car.	37 5 0
70% carbon-free	9½d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to 11 5 0
76/80% packed	£11 15 0 to 12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over 4d. lb.
Rounds and squares, under ½ in. to ¼ in. 3d. lb.
Do., under ¼ in. to 7/16 in. 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in. 3d. lb.
Do., under ½ in. × ¼ in. 1/- lb.
Bevels of approved sizes and sections 6d. lb.
Bars cut to length, 10% extra.

SCRAP

	£ s. d.	£ s. d.
South Wales—		
Heavy steel		2 17 0
Mixed iron and steel	2 11 0	to 2 13 0
Heavy cast iron	2 12 0	to 2 13 0
Good machinery	2 15 0	to 2 17 0
Cleveland—		
Heavy steel		2 12 6
Steel turnings		1 17 6
Cast-iron borings		1 7 6
Heavy cast iron		2 12 6
Heavy machinery		2 14 0
Midlands—		
Light cast-iron scrap		2 7 6
Heavy wrought iron		2 17 6
Steel turnings		1 14 6
Scotland—		
Heavy steel		2 10 0
Ordinary cast iron	2 11 6	to 2 12 6
Engineers' turnings		2 0 0
Cast-iron borings	1 17 6	to 1 19 0
Wrot-iron piling	2 17 6	to 3 0 0
Heavy machinery		2 16 6

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	33 0 0
Brass	20 0 0
Lead (less usual draft)	17 0 0
Tea lead	13 0 0
Zinc	10 0 0
New aluminium cuttings	68 0 0
Braziery copper	28 0 0
Gunmetal	28 0 0
Hollow pewter	155 0 0
Shaped black pewter	125 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—

Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	71/-
Hematite M/Nos.	70/6

N.W. Coast—

Hem. M/Nos. d/d Glas.	74/-
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-

Midlands (d/d Birmingham dist.)—

Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-

Scotland—

Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/- to 73/6

Sheffield (d/d district)—

Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
W.C. hematite	86/-

Lancashire (d/d eq. Man.)—

Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell. No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	81/6
Clyde, No. 3	81/6
Monkland, No. 3	81/6
Summerlee, No. 3	81/6
Eglinton, No. 3	81/6
Gartsherrie, No. 3	81/6
Shotts, No. 3	81/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	9 12 6	to 9 15 0
Nut and bolt iron	7 10 0	to 8 0 0
Hoops	10 10 0	and up.
Marked bars (Staffs) f.o.t.	12 0 0	
Gas strip	10 10 0	and up.
Bolts and nuts, ¾ in. × 4 in.	15 0 0	and up.

Steel—	£ s. d.	£ s. d.
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.	9 5 0	to 9 7 6
Chequer plts.		10 7 6
Angles		8 7 6
Tees		9 7 6
Joists		8 15 0
Rounds and squares, 3 in. to 5½ in.		9 7 6
Rounds under 3 in. to ⅜ in. (Untested)		8 12 0
Flats—8 in. wide and over		8 12 6
,, under 8 in. and over 5 in.		8 17 6
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 5 0	to 12 10 0
Hoops (Staffs)		9 7 0
Black sheets, 24g. (4-t. lots)		11 0 0
Galv. cor. shts. (,,)		13 0 0
Galv. flat shts. (,,)		13 10 0
Galv. fencing wire, 8g. plain		14 10 0
Billets, soft	5 10	0 and up.
Billets, hard	6 17 6	to 7 2 6
Sheet bars	5 5 0	to 5 10 0
Tin bars	5 5 0	to 5 10 0

PHOSPHOR BRONZE

	Per lb. basis.
Strip	10¾d.
Sheet to 10 w.g.	11¾d.
Wire	12¾d.
Rods	11¾d.
Tubes	14d.
Castings	12¼d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.31
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.85
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.40
Plain wire	2.30
Barbed wire, galv.	2.80
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	19/- to 20/-
Durham foundry	20/- to 21/-
,, furnace	16/6 to 17/9
Scotland, foundry	28/-
,, furnace	25/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	18/2 and up.
,,	28×20 ,,	36/4 and up.
,,	20×10 ,,	26/- to 26/3
,,	18¾×14 ,,	18/9 to 19/-
C.W.	20×14 ,,	15/6
,,	28×20 ,,	32/6
,,	20×10 ,,	22/9
,,	18¾×14 ,,	15/6

SWEDISH CHARCOAL IRON & STEEL

	£ s. d.	£ s. d.
Pig-iron	£6 0 0	to £7 0 0
Bars-hammered, basis	£16 0 0	to £16 10 9
Bars and nail-rods, rolled, basis	£15 15 0	to £16 0 0
Blooms	£10 0 0	to £12 0 0
Keg steel	£30 0 0	to £31 0 0
Faggot steel	£18 0 0	to £23 0 0
Bars and rods dead soft, st'l	£10 0 0	to £12 0 0

All per English ton, f.o.b. Gothenburg
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.	
Oct.	3 ..	35	5	0	inc. 5/-
,,	4 ..	35	13	9	,, 8/9
,,	7 ..	36	6	3	,, 12/6
,,	8 ..	35	12	6	dec. 13/9
,,	9 ..	35	16	3	inc. 3/9

Electrolytic Copper

		£	s.	d.	
Oct.	3 ..	39	10	0	No change
,,	4 ..	40	0	0	inc. 10/-
,,	7 ..	40	10	0	,, 10/-
,,	8 ..	40	0	0	dec. 10/-
,,	9 ..	40	0	0	No change

Standard Tin (cash)

		£	s.	d.	
Oct.	3 ..	224	15	0	inc. 35/-
,,	4 ..	221	10	0	dec. 65/-
,,	7 ..	227	10	0	inc. 120/-
,,	8 ..	228	0	0	,, 10/-
,,	9 ..	229	5	0	,, 25/-

Tin (English ingots)

		£	s.	d.	
Oct.	3 ..	225	0	0	inc. 40/-
,,	4 ..	222	0	0	dec. 60/-
,,	7 ..	227	10	0	inc. 110/-
,,	8 ..	228	5	0	,, 15/-
,,	9 ..	229	10	0	,, 25/-

Spelter (ordinary)

		£	s.	d.	
Oct.	3 ..	16	8	9	inc. 2/6
,,	4 ..	16	17	6	,, 8/9
,,	7 ..	17	6	3	,, 8/9
,,	8 ..	16	17	6	dec. 8/9
,,	9 ..	16	15	0	,, 2/6

Spelter (Electro, 99.9 per cent.)

		£	s.	d.	
Oct.	3 ..	19	1	3	inc. 1/3
,,	4 ..	19	10	0	,, 8/9
,,	7 ..	20	0	0	,, 10/-
,,	8 ..	19	10	0	dec. 10/-
,,	9 ..	19	7	6	,, 2/6

Zinc Sheets (English)

		£	s.	d.	
Oct.	3 ..	25	0	0	inc. 5/-
,,	4 ..	25	5	0	,, 5/-
,,	7 ..	25	15	0	,, 10/-
,,	8 ..	25	10	0	dec. 5/-
,,	9 ..	25	10	0	No change

Lead (English)

		£	s.	d.	
Oct.	3 ..	19	15	0	inc. 10/-
,,	4 ..	20	10	0	,, 15/-
,,	7 ..	21	15	0	,, 25/-
,,	8 ..	21	0	0	dec. 15/-
,,	9 ..	21	0	0	No change

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS DELIVERED SHEFFIELD

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	46 10	47 2	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	49 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	59 1	59 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	76 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 9½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 9½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	64 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	113 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	127 6	180 6	184 3	195 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	280 0	284 11½
1921	263 4	228 4	180 0	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1
1923	109 0½	116 5½	133 11½	138 3½	134 2	125 0	115 7½	111 9	110 0	110 0	113 11	115 0	119 5½
1924	115 0	115 0	114 4½	112 6	112 6	112 6	111 0	110 0	110 0	105 4½	102 6	102 6	110 3½
1925	102 6	102 6	100 0	98 6	97 6	95 1½	92 6	90 6	88 3	87 0	88 1½	88 9½	94 3½
1926	90 1½	90 0	89 8½	89 0	89 0	89 0	90 2½	91 9	94 0	97 2½	*	*	91 0
1927	95 4½	95 6	96 6	95 6	95 3	94 0	92 10½	91 6	90 6	90 6	90 6	89 6	93 1½
1928	85 0	85 3	85 5	85 0	85 3	84 9	84 0	83 9	84 0	84 0	83 1	82 6	84 4
1929	82 10½	83 6	85 0	86 9	87 0	87 0	87 3	87 2½	87 6	89 6	89 6	89 10½	86 11
1930	91 6	91 6	91 6	90 0	89 7½	88 0	87 7½	86 6	86 6	86 6	86 6	86 6	88 6½
1931	86 6	84 6	84 6	84 6	84 6	82 6	82 6	81 6	81 6	83 6	83 6	83 6	83 7
1932	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6
1933	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6
1934	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6
1935	83 6	83 6	83 6	83 6	83 6	83 6	85 4½	86 0	86 0	—	—	—	—

* No prices available.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

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ZETLAND ROAD, MIDDLESBROUGH.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

FOUNDRY MANAGER or Foreman seeks position with progressive firm; 15 years' experience general engineering castings, jobbing, quantity productions; good organiser and disciplinarian.—Box 414, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

QUALIFIED FOUNDRY ENGINEER, G.I.Mech.E., 15 years' experience light engineering castings and repetition work, requires progressive position in modern foundry. Good organiser and keen disciplinarian.—Box 422, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

THE British Foundry School requires a Laboratory Attendant with some foundry experience, preferably with City and Guilds Certificate in Foundry Practice or Pattern-making. Some knowledge of engineering drawing or photography a recommendation. 50s. to 63s. per week according to qualifications. Apply letter only to J. G. Pearce, 21, St. Paul's Square, Birmingham 3.

PETTY & CO. (Sir Reginald Ford and Mr. Bertram Weston) (Appointments Specialists) have the following vacancies to fill in India for single men; 4-5 years' agreement. Free passage out and home; quarters and high salaries for good men.

1. Foreman—Coke Ovens, age under 30 years.
2. Coke-Oven Manager, age under 38 years.
3. Machineshop Foreman, age under 35 years.
4. Assistant Manager—Blast Furnace, age under 35 years.
5. Blast-furnace Foreman, age under 35 years.

Call 53, Haymarket, London, S.W.1.

No preliminary fees.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of The Foundry Trade Journal.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

ASSISTANT FOREMAN MOULDER requires change. Good experience in iron and steel, general engineering and also specialised work. (268)

FITTER requires similar position in Lancashire area or as Foreman. First-class range and stove experience; knowledge foundry practice. Technical training. (269)

AGENCY

AGENCY wanted for Malleable or Steel Castings by foundry representative with good sound connection.—Box 420, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

PUBLICATION

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. A new edition will be going to press soon. *Write now* for full particulars and advertisement rates.—Industrial Newspapers, Limited, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY

WANTED.—Two or three Pickles Moulding Machines. Must be in good condition.—Box 418, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MORGAN P3 Pit Furnace; oil-fired lift-out type for 150-200-lb. crucibles, complete with burner, but without lining. £20 for quick sale.—Rhodes, Queen Street, Romford. Telephone: Romford 95.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. Davies & Son, West Gorton, Manchester.

SANDBLAST PLANTS

Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

Cabinet Plants, in sizes 4 ft. x 4 ft. x 4 ft., 36-in. dia. and 30-in. dia. operators' cabinets.

Most of the above by Tilghman and complete with Air Compressors.

HAND MOULDING MACHINES

By Adaptable, Pridmore, Darling & Sellars, etc.; Squeezers by Utard (unused), Samuelson and Britannia, also Farwell Universal Type.

Ladles, Grinding Machines, Exhaust Fans, Blowers, Air Compressors and 500 Electric Motors and Dynamos.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.

CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.

'Phone: Broadwell 1359.

THOS. W. WARD LTD.

No. 8 "Sturtevant" belt-driven BLOWER, with two side inlets each 18" dia., one outlet 13" dia.

Gas Furnace (Brayshaw); three jets; 1½" dia. inlet; inside dimensions, 24" long, 18" wide, 9" high.

Two first-class Babcock W.T. BOILERS; new in 1927; heating surface, 1,966 sq. ft.; each 205 lbs. w.p.

Write for "Albion" Catalogue.

Grams: "Forward." 'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD.

'Phone: 287 SLOUGH

SAND PLANT

Herbert Whizzer, large size. **£48.**
Brealey Disintegrator, NEW. **£26.**
Pneumatic Riddles, Jackman type. **£9 each.**

SANDBLAST PLANT

BARREL PLANT by Tilghman, *as new*, 60"×40". Price **£240.**

NEW 8'×8' ROOM PLANT, complete. Price **£230.**

CAST IRON ROOM PLANT, 12'×9', complete with 400 cu. ft. motor-driven compressor for A.C. current, in new condition. Cheap.

Several small complete barrel plants in stock.

Genuine Stevenson 30-ton Crane Ladle, NEW. Price **£75.**

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant.*
14, AUSTRALIA ROAD, SLOUGH

MISCELLANEOUS

TWO TONS of steel-strip scrap available monthly, containing 20-22 per cent. chromium. What offers?—Box 400, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

SELECT YOUR MACHINE
FROM THE
LARGEST
STOCK OF HIGH-CLASS
SECONDHAND
MOULDING MACHINES
IN THE WORLD
Practical Advice Free

THE COLEMAN FOUNDRY EQUIPMENT Co LTD
156, STRAND, LONDON, W.C.2.

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SANDBLAST
THINK OF
RICHARDSON'S
Established 1887.

We Supply Re-Conditioned & New
SAND BLAST PLANTS
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